In This Issue: Full Evidence on the Quebec Bridge Accident (with insert)

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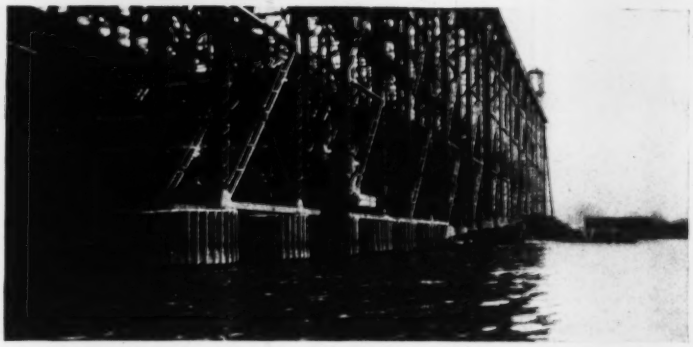
"The results on this work fully justified the use of Lackawanna Steel Sheet Piling and were a repetition of our previous good experience in its use."



The repeated use of Lackawanna Sheet Piling by such experienced contractors as the Armstrong & Latta Co. would seem to indicate that Lackawanna performance and economies are decidedly profitable. Other contractors who have become familiar with the possibilities obtainable only from the Lackawanna type of interlock have come to the same conclusion—especially that the United States Government has set the example by using Lackawanna Sheet Piling on its best and largest jobs.

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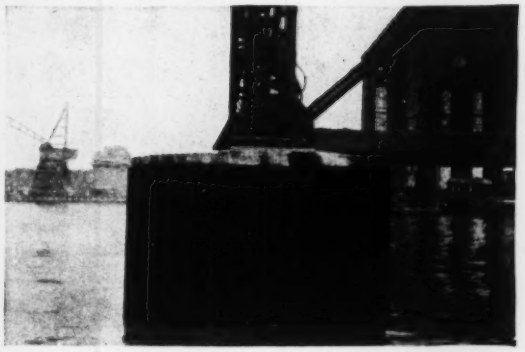

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Engineering News

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Steel Sheetpile Coffer-Dams for Troy Lock and Dam

By D. A. Watt*

SYNOPSIS—Several types of coffer-dam were used to lay dry Hudson River preparatory to construction of lock and dam at Troy, N. Y. Article in "Engineering News," Sept. 14, 1916, described timber and gravel dams. This article describes sheetpile cylinder coffers and earth-fills with sheetpile center line.

In the construction of the lock and dam at Troy, N. Y., the west end of the dam was built behind timber coffer-dams, as described in the previous article. Before and after their completion, construction proceeded on the lock itself and the east section of the dam. The lock and lower guide wall were built inside coffer-dams, but the foundations of the upper guide wall were built in the water, as the amount of masonry was too small and the water too deep to warrant the expense of a coffer-dam for them. The lock coffer was made in two sections, partly to save time in construction and partly to save piling, for by completing the head walls and the river wall first, the masonry could be used to replace some of the coffer and the piling be removed for use in the second coffer. The first, or upper, coffer-dam (No. 2) was located in the main channel of the river. As it had to remain in place for not less than two winters with attendant exposure to floods and ice, besides having to carry an unusual head of water, its construction had to be reliable in all respects. It would block up more than a third of the river's area of discharge, and during and after the construction of the west arm of

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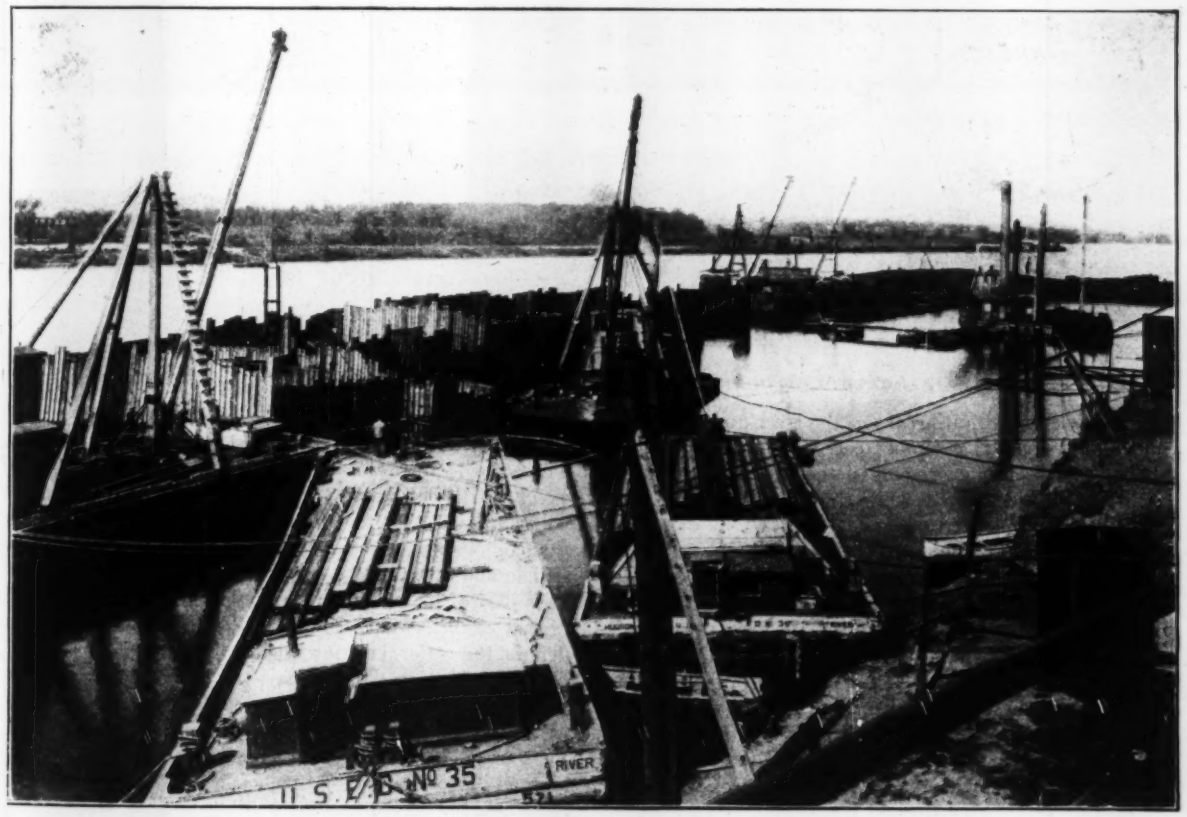


FIG. 1. STEEL SHEETPILE POCKET COFFER-DAM ON EAST SIDE OF RIVER AT TROY, N. Y.
This is a view of coffer-dam No. 2, looking north

the dam about another third would be closed. The flood velocities past the coffer would therefore be very high, tending to scour away any outside banking, which in turn would result in leaks through the coffer-dam unless the latter were water-tight in itself.[1] In addition to this the water about 50 ft. out from the banks reached a depth of 20 ft., which gradually increased to a maximum of about 27 ft. With 7 ft. added for the working range of floods, all but a small portion of the coffer-dam would have to support a maximum head of 27 to 34 ft. Any kind of timber framing for such a load would need to be very heavy and would be difficult to place reliably in the depths at the site and difficult to hold in the current until the filling could be put in. Moreover, wooden sheeting could not be driven into the gravel bed for any distance without splitting; and if it were not driven and reliance placed instead upon outside banking, the latter would be liable to be washed away by the strong flood currents, with resultant breaks of the river underneath the coffer-dam. Lastly, a timber coffer of large size would not be easy to clear away and in the process most of the pieces would be destroyed, while those that might be saved would have no market value.

These considerations led to the adoption of steel piling placed as a series of pockets, since the latter could be made of any size necessary to be stable in themselves. The piles could also be driven to or nearly to rock, thus removing the dangers of undermining; they could be pulled without undue injury and would then be available for use in later coffer-dams; and when finally done with, should be available for sale as scrap for nearly a third of their first cost. Comparative estimates showed that the wooden type would be about as expensive as the steel type, after allowing only a 33% salvage value for the piling of the latter, and it had in addition the serious disadvantages just enumerated. Now that all construction has been completed, it has become apparent that the adoption of the steel was decidedly economical. Three coffer-dams were built with the original bill of piling (which included only enough for the first coffer plus about 10%); enough surplus piles were available for sheathing for deep excavation and for protecting the coffers in front of the old dam; and a large salvage value was obtained.

Designing the Sheetpile Cellular Coffer

In proportioning the sizes of parts the pockets were assumed as having no back pressure from inside the coffer and as being subjected on the outside to a head of water measured from the rock to the top of the pockets, which were run up to about 7 ft. above pool level. This gave pressures of water varying from about 21 ft. to 41 ft. (see profile, Fig. 4). To this was added the comparatively slight pressure from the material overlying the rock. These loads were to be counterbalanced solely by the weight of the fill taken as 110 lb. per cu.ft. for the upper half and as 65 lb. for the lower half. It may be noted that in closed pockets of this type much of the fill is still immersed after the coffer has been unwatered and so loses part of its weight, since the leakage from the outside cannot readily escape. Thus in the 50-ft. diameter cylinders of the coffer-dam for raising the battleship "Maine," filled chiefly with a sandy clay, the line of saturation was very high, following an inclination from near the outside water line of about 1 vertical to 5 horizontal, and all efforts to remove or intercept the seepage by means of numerous perforated pipes and box wells sunk 20 to 30 ft. deep in the fill proved unavailing. This seepage was infinitesimal in amount, but it sufficed to keep the fill in a fluid state to within a few feet of the top.

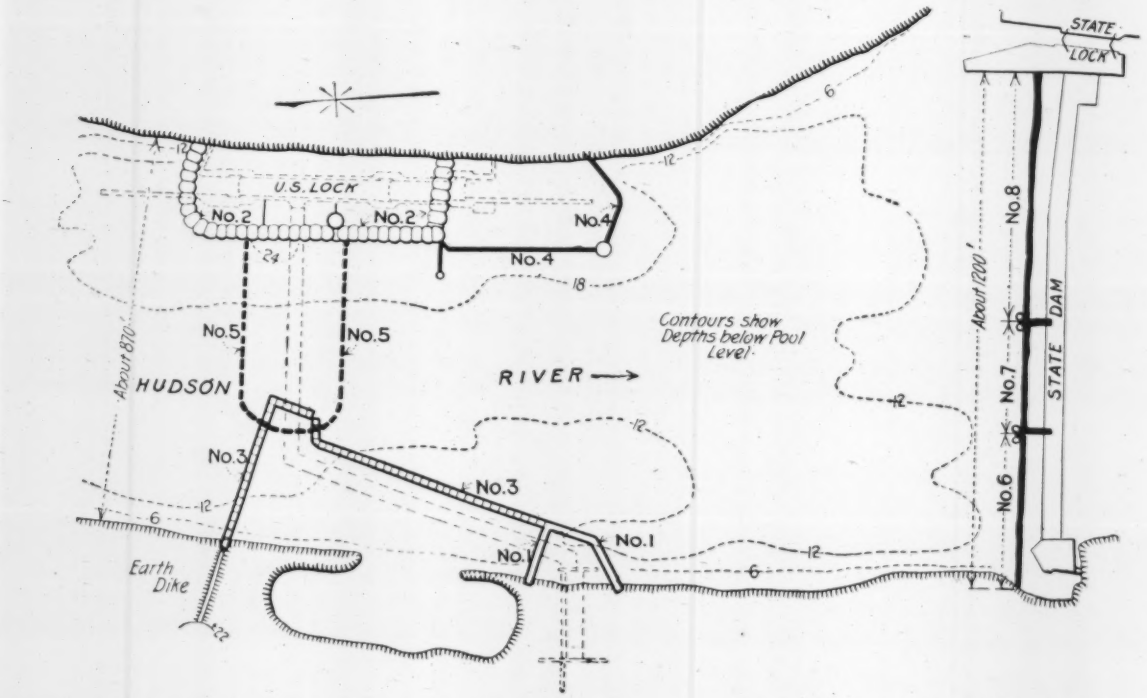


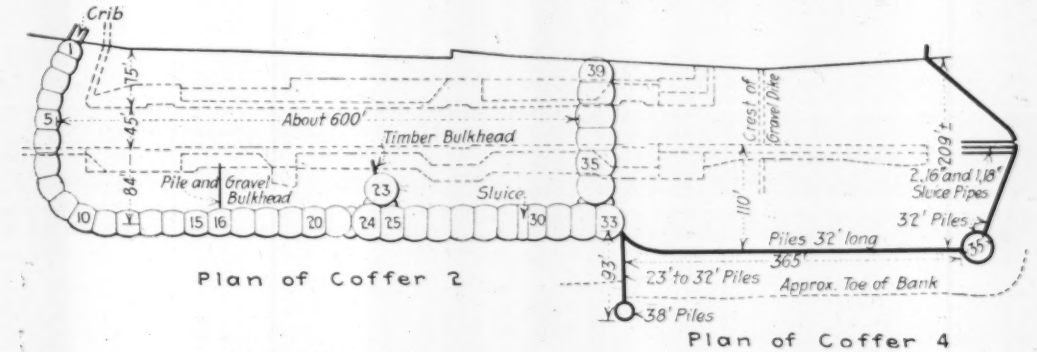
FIG. 2. GENERAL LOCATION OF COFFER-DAMS IN CONSTRUCTION OF LOCK AND DAMS AT TROY, N. Y.

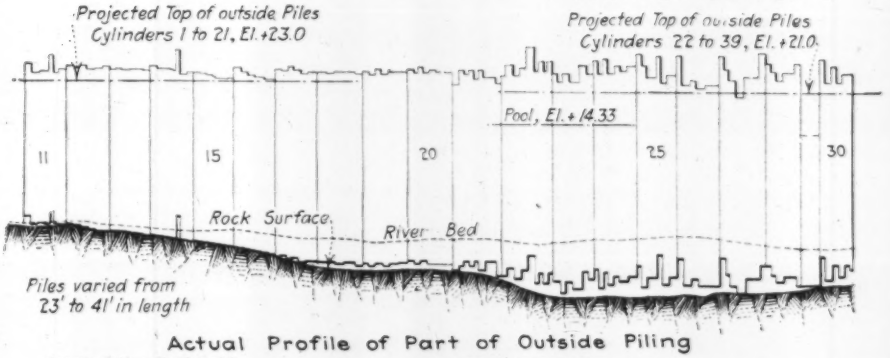
[1] Measurements taken at the height of subsequent floods showed a fall ranging from 1 to 2 ft. between the upper and lower ends of this coffer-dam, causing velocities which at times resulted in the suspension of navigation.

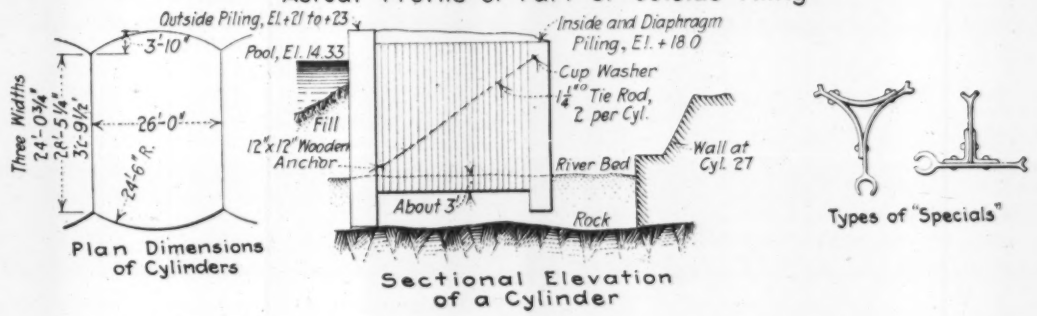
The angle of repose of the fill was taken as 1 vertical to 2 horizontal, and no support from the diaphragms against sliding was assured, as it was evident that their piles would tend to slide along their joints under any stress.

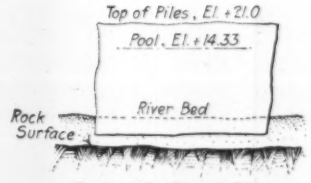
As proportioned by the foregoing assumptions, the theoretical resultant of vertical and horizontal pressures came a little within the middle third. This, however, was merely a theoretical safety, as the weakness of coffer-dams of the gravity type usually consists in excessive pressures at the toe or in an overload of horizontal shear. The latter is the more common source of danger, and in point of fact most of such structures will be found on analysis to be balanced near or beyond the edge of a theoretical safety against this stress. In the present case the water pressure and the sliding resistance of the fill (assumed as having a coefficient of 0.5) were nearly balanced, and to add a factor of safety two 1¼-in. rods were placed in each cylinder, as shown in Fig. 4.

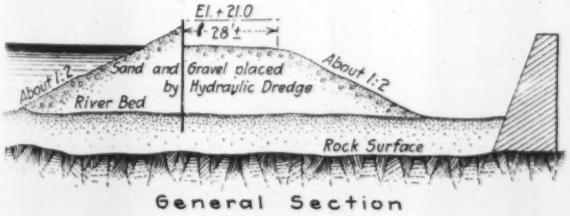
Trials proved that the most economical size of pocket to meet the foregoing assumptions would be one with a width of 26 ft., having its outer and inner faces curved to a radius of 24½ ft. and joined by straight diaphragms, and of a horizontal depth varying to suit the depth of water (see Fig. 4). The outer and the inner face piling were made long enough to reach to rock except where the rock was low, when the inner piling was made 3 ft. shorter and driven that much less, while the diaphragm piles were made in general only long enough to drive 2 or 3 ft. into the river bed, below which point it was assumed that the




Projected Top of outside Piles Cylinders 1 to 21, El. +23.0
Projected Top of outside Piles Cylinders 22 to 39, El. +21.0
Pool, El. +14.33
Rock Surface
River Bed
Piles varied from 23' to 41' in length
Actual Profile of Part of Outside Piling







FIGS. 3 TO 5. PLANS AND DETAILS OF COFFER-DAMS NOS. 2 AND 4

Fig. 3—Enlarged plan of coffers Nos. 2 and 4. Fig. 4—Details of coffer No. 3. Fig. 5—Details of coffer No. 4

tendency of the filling to rip the pockets apart would be resisted safely by the bearing against the gravel. The piles were specified to be made with an ultimate tensile strength of interlock of 8,000 lb. per lin.in., and the possible angle of inclination to each other was to be 15°.

About 1,900 tons of piling of 38-lb. section (equivalent to about 3,400 separate pieces) were purchased from the Carnegie Steel Co., the lowest bidder, at $35.20 per ton for plain piling and $15.20 per ton for junctions or "specials" (Fig. 4). A salvage value was agreed on, f.o.b. cars at Troy, of $10.71 per ton for specials and for piling 30 ft. long or under, and the same price for damaged longer piling. Long piling which had 30 ft. in a condition suitable for redriving was to be paid for at $26 per ton for the undamaged portions. The lengths varied from 23 to 41 ft., about 40% of the total number being 32 ft. The hole in the end of each pile, usually made about 1 in., was specified to be 2½ in. in diameter, and this was found much preferable to a small one when handling.

Method of Driving the Pockets

Driving was begun at the north end, the piles being set around a templet of 2-in. plank, some of which can be seen in Fig. 1. At the south end the water-tight connection with the bank, or "cutoff," was made by a line of single piles joined to the bank pocket, and at the north end a dirt-filled box was used. At first a full templet was employed, but later a half one gave better results, as it allowed more freedom of movement for the driving boats and was more easily picked out of the finished pocket. The best progress was made by setting up several piles along the templet before driving, as this took the least shifting of tackle, and the piles, being interlocked with the preceding pocket, could not fall over. A considerable number of pockets was set before any filling was done, the first one (No. 1 in Fig. 3) serving as an anchor for the rest, as its piles were driven several feet into the bottom. The adjacent pockets, although resting on practically bare rock, showed little tendency to lean. If this occurred, they were pushed back by a tugboat and then guyed until they could be filled. One or two of the pockets farther down the line, where the piles were driven to a penetration of several feet, got out of plumb considerably in driving and could not be straightened; they were therefore filled as they stood.

The maximum penetration was not over 8 or 9 ft. and in most cases was considerably less, as the gravel was compact. Thus, although the piles had been ordered long enough to extend to rock, few of them reached it except where the gravel was shallow. The profile of some is shown in Fig. 4.

For the handling and driving, derrick boats were employed almost entirely, on account of their wide reach. Three steam hammers of a standard make did the driving, and one or another and often two of them would be out of commission most of the time on account of breakdowns. This gave permanent and expensive employment to several machinists and caused a steady loss of efficiency in the driving crews. An experiment with a view to avoiding this expense was made with a hammer devised by the mechanical engineer, E. C. Quinlivan. It was a home-made affair of heavy bar iron which straddled the pile and was worked by a single line, the knuckles of the pile itself serving as guides. This hammer seemed to possess many possibilities; and if the driving had not been nearing a conclusion, it would have been experimented with further.

When closing a pocket, eight or ten piles were set up on each side of the gap, interlocked with the last piles driven, but themselves resting on the river bed. This was necessary to give flexibility enough to let the closing pile be set. As soon as several pockets had been completed, filling was begun by a hydraulic dredge using sand and gravel from the site of the new channel. The fill was made in about 6-ft. layers, moving from pocket to pocket as each layer was finished, so as to avoid distorting unduly the straight sides.

One point had been overlooked, however—that of providing a low-level outlet for the water from the discharge, which had to rise in consequence some 5 or 6 ft. above the river level before it could escape over the tops of the piles. As a result the pockets were forced temporarily into a cylindrical shape; but by regulating the placing of the gravel in the adjacent pockets the sides drew back to nearly their original straightness, and even where they retained a considerable bow, no harmful results occurred. The outward movement of the sides from the water pressure was fan-shaped, as the bottoms of the piles were held fast in the river bed. This distortion could be prevented by having one or two low piles over which the water could escape, the opening being closed by plank as the filling climbed up. Such an opening should preferably be placed on the river side if a hydraulic dredge is used; otherwise the silt in the overflow would spread over the coffer inclosure and make an overlay of some inches of mud. A small amount of filling was also placed against the inner and outer faces of the cylinders, to assist in checking leaks. Most of that placed outside at the upper corner was washed away by the flood currents before the coffer-dam was abandoned.

The first pile of this coffer-dam was set about the middle of July, 1913, and the filling was completed and unwatering begun about the end of the following November. The structure was nearly water-tight; practically no seepage took place through the pockets and not much underneath them, and except in floods one 12-in. centrifugal pump, lifting about 45 ft., was sufficient during the greater portion of the work to keep down the water. No repairs of any kind were needed, nor were any difficulties caused by leakage, although the coffer was exposed to two winters and to many floods and was kept unwatered during part of the first and all of the second winter. It was flooded several times, once because of the failure of the river and harbor bill, once through the suspension of work for the season, and the other times because of floods that began to overtop it. No deformation of pockets was at any time visible to the eye, and observations taken to ascertain if any were beginning to lean inward at the top showed a maximum movement of 2½ in., near pocket 23. With the majority of the pockets there was no movement at all, and after the first few weeks all movements ceased. The portion last used was finally abandoned on Aug. 1, 1915, when the lock was complete and ready for navigation. The removal of the piling will be made the subject of a separate article.

Cost of Cellular Coffer-Dam No. 2

In giving figures for the cost of the steel coffer-dams it is believed that the figures most useful would be those based on the cost of each one assumed as a separate unit. The data given below are therefore based on the supposi-

tion that the first-lock coffer-dam was built with piling used for that structure only and that the piling was then sold; and that the filling and banking were disposed of directly into the spoil banks and not used again for other coffer-dams. The actual cost, however, was much less than under this supposition. The other two steel coffer-dams were built with the piling from the first coffer, so that no additional piles had to be purchased for them; and most of the filling and banking of one coffer was used over again for the next one, the final removal to the spoil banks being made only when the last coffer-dam was done with.

3,079 piles (2,000.05 short tons) @ $35.20 per ton			$70,402
90 specials (119.33 tons) @ $45.20 per ton			5,394
Tie-rods, 7 tons @ $45.20			316
Washers, 1.7 tons @ $65			111
Total metal			$76,223
Salvage value:	Short Tons		
Piles, etc., under 30 ft.	266.0		
4% estimated waste on longer piles	74.4		
Total scrap	340.4	@ $10.71	$3,646
Merchantable	1,785.6	@ 26.00	46,426
Total salvage			50,072
Net cost of metal			$26,151
Unloading, yard work and transporting piles, 3,169 pieces @ $1			3,169
Templets, making and handling			1,200
Setting and driving piles @ $2.60*			8,250
Setting tie-rods, 70 pieces @ $5			350
Filling and banking, 65,000 cu.yd. @ 20c. for placing and 20c. for removing			26,000
Jacking and pulling piles, at about $3.50*			11,092
Transporting, sorting and loading, at 50c.			1,585
Miscellaneous work			10,660
Total cost			$88,457
Cost per linear foot (1,000 ft.)			$88.46

*Of these amounts labor was about 74%, repairs 6% and supplies 20%.

The foregoing are field costs of construction and removal and include ordinary running repairs. They do not include depreciation or district-office costs, or supervision above the grade of foreman.

Single-Line Sheetpile Coffer-dam

The second coffer-dam (No. 4), to inclose the remainder of the lock, was attached to the first one and consisted of a single line of steel piling, about 650 ft. in length, with a protecting spur at its upper end and an anchor cylinder at the lower corner. Relying on the experience obtained with the first coffer, the piles were driven only 5 or 6 ft. into the river bed, and no attempt was made to reach the rock (Figs. 4 and 5). The banking was relied on to provide resistance to seepage and stability, the width of the inner bank being made sufficient to resist sliding. Most of the piles used were taken from the first coffer, as by September, 1914, the lock had been completed far enough to allow its river wall and head walls to replace much of the coffer-dam, assisted by the bulkhead from cylinder 16, shown in Fig. 7, of the plan Dam No. 5

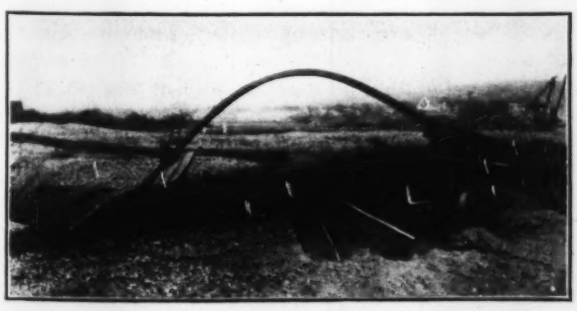


FIG. 6. PILES DISTORTED BY FLOOD

The line of piling was located far enough from the proposed masonry to avoid trouble from too steep excavation slopes, and all the banking below water level was placed by the hydraulic dredge and taken from the site for the new channel or from the first-lock coffer-dam. The inner bank was never built up above the water line, but the outer one was raised a few feet by using derrick boats and orange-peel buckets. As the style of construction provided no tension in the interlocks and any water percolating to the piles would therefore tend to escape through the joints, the latter were filled with river sand poured in from the top, with the view of stanching them. Before

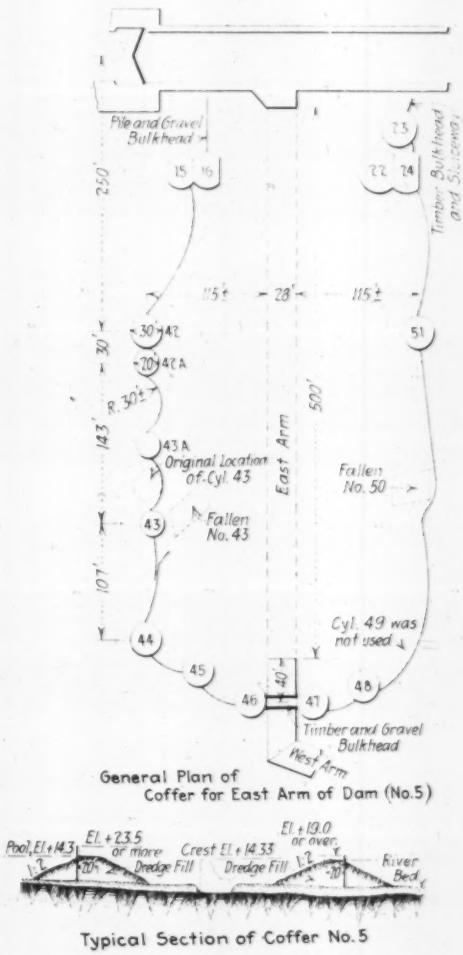


FIG. 7. PLAN AND DETAILS OF COFFER FOR DAM NO. 5

this was done, however, and before the outer banking had been raised, a flood came that rose several feet upon the unprotected faces of the piles, and at many points there was a copious leakage that washed down a good deal of the bank. By the time the next flood came, however, the joints had been filled and the banking finished. The latter in many places was several feet below the flood level, which rose until the water began to run over the low piles; but the joints now proved entirely water-tight except for a little seepage, and the steel wall, unsupported or cantilevered above the top of the inner banking, held without difficulty the pressure of the water, amounting to a head of about 6 ft.

Pumping out was begun on Jan. 9, 1915, and was carried on slowly until Jan. 16, on which date the bottom

was reached. One 12-in. centrifugal pump, running about one-third of the time thereafter, kept the inclosure empty. About four weeks later the division between the two coffer-dams was cut through, and the leakage was then run north to the main sump. During its existence the coffer-dam was partly flooded once, and once entirely, due to high water. The latter flood tested severely the breakwater before described, and the current around its end ran 6 or 7 mi. an hour; but fortunately no harm resulted, and the protection it afforded saved from erosion the adjacent coffer banking.

By April, construction had advanced far enough to allow removing some of the piling for use in the coffer-dam for the east arm of the dam, and a cutoff dike of excavated material was therefore built just below the main lock walls, as shown in Fig. 3, and pile pulling was begun. The dike and the remains of both coffer-dams were kept in service until Aug. 1, 1915, when the dredge began the removal of the former and opened the entrance for navigation.

Cost of Single-Line Coffer

The cost given below is based on the assumptions described for the cost of the first-lock coffer-dam—namely, that each coffer was a separately paid for structure. Field costs only, as specified for the other coffer, are given.

397 piles (470.2 short tons) @ $35.20 per ton			$16,551
8 specials (9.6 tons) @ $45.20 per ton			434
Total			$16,985
Salvage value:	Short Tons		
Piles under 30 ft. and specials	91.3		
15% estimated waste on longer piles	15.5		
Total scrap	106.8 @ $10.71	$1,145	
Merchantable	373.0 @ 26.00	9,698	
Total salvage			$10,843
Net cost of metal			$6,142
Unloading, yard work and transportation, 805 pieces @ $1			805
Templets for 2 cylinders			100
Setting and driving piles @ $2.10			1,690
Banking, 40,000 cu.yd. @ 20c. for placing and 20c. for removing			16,000
Pulling piles, at about 75c.			604
Transporting, sorting and loading, at 75c.			604
Miscellaneous work, 10%			2,590
Total cost			$28,535
Cost per linear foot (main coffer, 650 ft.; breakwater, 90 ft.; total, 740 ft.)			$38.55

Combination Cylinder and Single-Line Coffer

The third and last steel-pile coffer-dam was used to complete the unfinished portion, 500 ft. in length, of the east arm of the dam (No. 5), Fig. 7. Its design was an evolution of the second-lock coffer and the general conditions to be fulfilled were that the masonry of the dam had to be completed in one season or the expense would have to be incurred of a coffer-dam that would successfully outlive the winter floods and act as a substitute in 1916 for the old dam downstream, which by that time would have been removed from the new navigation channel. It was therefore decided to endeavor to complete the masonry in a single season.

Having the steel piles on hand, the adoption of a wooden coffer-dam was not considered, as it would have involved buying additional material and the type would be more vulnerable to floods. The plan chosen comprised a single wall of steel piles supported by banking, generally similar to the second-lock coffer-dam. Four principal changes were made, however: No driving was done (except for parts of the cylinders specially exposed to undermining), but the piles were merely rested on the bottom of the river; anchor cylinders were used about 100 ft. apart, so that if high water pushed over any of the line piling while being set up, the damage would be checked at the nearest cylinder; the width of the inside fill was made 20 ft. at the water line instead of 28 ft.; and the fill on the outside was not raised above the low-water line.

The last-named feature saved a good deal of banking and was adopted from the experience with pouring sand in the interlocks of the second-lock coffer in order to make the joints water-tight. The method proved equally successful in the present case. No special lengths of piles were used, but random lengths were set up as they came delivered on the barges. The ends of the coffer-dam at the lock were joined to portions of the lock coffer-dam which had been left in place for that purpose. The width between north and south lines was made ample, so as to accommodate the trackage and leave a large margin for spoil, etc. (see Fig. 7).

The program was to begin setting up cylinders 44 to 48 inclusive with their connecting diaphragms (Fig. 7) as soon as the spring floods had passed; to complete the remaining cylinders next; and finally to link them together with the line piling. The flow was to be shut off when ready by the line between cylinders 42 and 43, and the final closure made between 50 and 51. A diameter of 30 ft. was chosen for the cylinders, to give ample stability, and the line piling was bowed downstream so that if a flood came before the banking was in place there might be less chance of distortion than with a straight line. It was not anticipated that the attached cylinders could give much support under such conditions, as their diameter was too small.

Pile setting was begun the last week in April, 1915, and was continued leisurely, as it was inadvisable to have much of the work in place before the June rise. The west cylinders were placed and filled, and the isolated cylinders in the river were then begun. Some of these gave trouble, as the rock had been swept bare in places by the concentration of the currents, and guys had to be used to hold the piling up. More than once the guys slipped, sometimes owing to boats fouling them, sometimes to other causes, and the piling fell over. No harm seemed to be done, however, to the pieces, and in one case where the cylinder had been closed just before falling it was fished up and set on its feet again with two or three days' work, apparently little the worse. Finally it was judged advisable to pump a small bank of gravel onto the bare rock where these troubles were liable to occur. The piling was then set up and driven into this holding ground and lashed with guys until it could be filled. This method proved successful in avoiding future trouble. Where the bed was naturally of gravel, occasional members of the piling were driven into it for 3 or 4 ft., holding up the cylinder.

Troubles Due to High Water

By the end of June all the cylinders had been placed, as well as the line piling of the upstream arm, except for the center bay, and much of the downstream line running east from cylinder 48. Thereupon began one of the wettest seasons on record, which continued without a break until the spring of 1916. The first flood undermined cylinder 51 until it sank under the water, while three other cylinders (42, 43 and 50) were somewhat flattened from loss of filling, but otherwise held their own. The end of the downstream line piling was also pushed over. At the

height of the flood the slope over the site of the coffer was 13 in. As soon as the water receded, the three flattened cylinders were restored satisfactorily by pumping in more filling, and work was begun on hoisting the fallen one and the downstream line.

Just a week after this flood, however, another and much worse one came, causing a head of 2 ft. at the coffer site. Cylinder 42 was again flattened, and 43 and 50 disappeared under the surface. About 50 ft. of the line piling attached to 43 went down also. It was found later that this cylinder had been revolved by the current and had been torn loose and thrown down under the line piling, which settled down on top of it. The general effect of these floods on some of the piling is shown by Fig. 6.

A week after the height of the flood, boats were able to get out into the current and start repairs. Six hoisting boats, extemporized and otherwise, were employed thereon. The flattened cylinders were restored satisfactorily by pumping in filling, and all but two of the fallen ones were set up and similarly refilled. Although their appearance when restored was decidedly disreputable, they were able to perform their duties satisfactorily. Cylinders 43 and 50 were found to be half buried in banks of gravel. After several attempts to pull them up, they were abandoned and still lie on the bottom of the river.

This flood and the apprehension of others to follow made necessary a revision of the plan for closing the coffer-dam. Had the season been normal, there would have been low water by the end of July, and the two navigation pools immediately upstream in the Mohawk and Hudson Rivers could then have been drawn down several feet and been allowed, when all was ready, to fill up again, temporarily cutting off all discharge and current in the Troy pool. In the still water thus secured the closure could have been made in less than eight hours. No low water could now be relied on, apparently, and it was evident that the closure must be made with the still abundant flow. To do this, two new cylinders 43 and 42a were set up as shown in Fig. 7, one near the abandoned 43 and the other adjoining 42, which was leaning too much to provide any interlock. The line piling between 43 and 44 was then completed, the new piles merely overlapping the end of the line, which was badly twisted. A third new cylinder, 43a, was next set up in the middle of the opening, leaving about 45 ft. clear on each side to be closed by line piling. These three new cylinders rested on bare rock, except part of 43, which overlapped the remains of the banking.

Experience with the fallen and the flattened cylinders had shown that even where the rock was bare, the feet of the piles of a cylinder might not all reach it, especially of those driven in closing, and that where there was an opening of only a foot or so under a single pile a strong current would gradually suck out the filling and perhaps cause a collapse. To prevent such trouble, riprap was thrown inside the three new cylinders, chiefly against the piling, to a depth of about 5 ft., and the filling was then pumped upon it. It may be noted also that the diameter of the cylinders was reduced from 30 to 20 ft.

Were the writer designing other structures of this type he would use cylinders of the smaller diameter, as with inside layers of riprap as described they would weather any ordinary flood as safely as the larger ones. Although the riprap makes porous spots in the coffer-dam, no trouble results, as was proved in this case, where the outside and the inside banking formed a blanket of sufficient thickness to care for such local weaknesses. Another point to be mentioned is that the closure should be made on the side least exposed to the current, so that if the closing pile does not reach the bottom, there will be less force of water to play into the opening.

This work was interfered with by two small rises, but was made ready for the final closure on Aug. 12. When placing the new cylinders the side connection piles had been fitted with eye-bolts carrying two 7/8-in. steel cables, intended to make horizontal loops for supporting the closure piling while being placed in the current. One cable was about 3 ft. from the bottom and the other about 3 ft. below the water surface, and they were designed to support a 3-ft. head on the piles. One end of each cable was brought to the top of the cylinders, so that the loop could be tightened or slackened if found necessary. These loops acted in reality only as guard cables, as when setting the closure piling the pieces were driven until their feet bit into the shale rock, and occasional piles were guyed to the derrick boats, holding the line until final closure could be made. Two derrick boats, working continuously for nearly two days, closed the two gaps successfully by Aug. 14. The depth of water in which the piling was set varied from 21 ft. at cylinder 43 to 29 ft. at cylinder 42a, and the head as the closure progressed rose from 0.2 to 0.7 ft., as much as possible of the discharge being passed through the lock and the power bulkhead openings.

Less than a week after the north arm had been closed the fringes of the Galveston hurricane of 1915 passed over the watershed, and on the night of Aug. 22 the river began to rise sharply. By next day the water was flowing over the crest of the masonry dam at cylinder 46 with a depth of 7 ft. and with the cross-current from the oblique arm began to erode the incomplete protection and to suck the filling out of cylinders 47 and 48. Much material was pumped back into them by the dredge, and where practicable the piles were driven farther down; but the filling still escaped, and by the second day the cylinders were creaking and swaying ominously. In one of the cylinders a single pile was found to be causing the trouble, as it had jammed about 4 ft. above the rock, leaving a gap through which the filling was sucked out. Just inside the river faces of both cylinders, therefore, and inside the line piling, riprap was thrown until all gaps appeared to be blocked up, and new filling was then pumped upon it. This stopped all trouble. The same currents had pulled loose the timber closure between cylinder 47 and the masonry dam, and this had to be replaced in water 18 ft. deep and in a river current running over 6 mi. an hour, requiring much patience and care to accomplish.

All restorations were completed after two days' work, and the closure of the south arm was proceeded with and completed on Sept. 3. The dredge completed the banking on Sept. 10, pumping out having been begun three days before with two 12-in. electric pumps. A third 12-in. and two 6-in. pumps were added a few days later; and a 10-in. centrifugal steam pump followed, as it was imperative to have an ample breakdown service owing to the long perimeter of the coffer-dam (about 1,300 ft.) and to the depth of water upon the banking (from 16 to 28 ft. at low water). By September 13 the water had been lowered about 18 ft., the pumping being proceeded with leisurely so as to drain the inner banking slowly and allow the coffer-dam to adjust itself to the pressure. Excavation was

begun the same day, but another rise stopped operations for a few days, and the closure had to be partly flooded. When pumping was resumed, the water was lowered to about 23 ft. below the river level and could be held there without difficulty by two 12-in. and the one 10-in. pumps, lifting about 35 ft. Thereafter, as the banking seasoned, the leakage steadily decreased until one 12-in. pump and about one-quarter of the capacity of another 12-in. pump could take care of it.

Excavation was resumed on Sept. 18, and the first concrete was laid on the twenty-third. The full length required, 500 ft., was completed five weeks later, on Oct. 29. Although several rises occurred during this time, the coffer-dam was kept unwatered, though once or twice it was a toss-up whether or not the water should be let in. Counting from July 1, eleven rises, large and small, passed down the river before the coffer-dam was done with. The pumps were stopped for the last time on Nov. 3, and the river was practically free of obstructing piling three weeks later. The piles were removed very rapidly, as few pieces had been driven, and the only difficult work was with the distorted cylinders and the torn north line. One clump of piling was removed from the latter consisting of about 25 pieces twisted and locked together. They had to be cut apart on the bank with an oxyacetylene torch.

The coffer-dam proved quite satisfactory. Its speed of construction, aside from delays by floods, was limited only by the capacity of the hydraulic dredge to supply filling and banking, and the use of line piling with isolated cylinders allowed the construction to proceed step by step with a minimum of risk of losing previous work. The damaging floods of July and August would probably have caused a total loss with a wooden coffer-dam, whereas very little of the displaced steel piling could not be pulled up and reset. The structure proved almost entirely watertight, and when done with, its removal was very rapid, being limited practically by the capacity of the dredge to dispose of the banking.

On account of the changes and repairs resulting from the abnormally wet season, it would be difficult to give costs comparable with those of a normal year. As compared with the second-lock coffer-dam, however, the difference in cost per linear foot would not be great, for while the cylinders increased the proportion of piling, the reduced width of the banking and the lessened cost of placing and removing the piles, due to eliminating most of the driving, effected a considerable saving.

Engineers in Charge of Work

The work was performed under the supervision of General (then Colonel) William M. Black, now Chief of Engineers, United States Army, with Captain R. D. Black as local engineer officer, succeeded in 1914 by Major M. J. McDonough. The fieldwork was commenced by Assistant Engineer A. C. Harper and continued by Junior Engineer J. J. McCabe. The mechanical work was under Wm. O. Quinlivan and the office work under Junior Engineer F. P. Fifer. The writer supervised the work locally.

Municipal Dock Construction is to be undertaken by the City of Albany, N. Y., in order to carry out its scheme of river front improvement. The city made an agreement with the Hudson Navigation Co. to build a pier on the river front with buildings for the handling of passengers and freight, but the company has failed to carry out the work. An ordinance has therefore been introduced under which the city will issue bonds to cover the cost of the work and will lease the buildings when completed to the Navigation Co.

Development of Government Railways in China*

By C. C. Wang†

Since the introduction of railways in 1876, China's railway policy has undergone a number of changes. At first it was a general policy of opposition, as shown by the fate of the Shanghai-Woosung Railway.[1] The ignorance regarding the new scheme of transportation, the general prejudice against foreign innovations, the fear of foreign influences and the deep-rooted superstition, together with the untactful behavior and irregular methods used by some of the foreign promoters—all these combined to prevent the introduction of the new means of transportation. Moreover, the apathy against railways was not limited to any one class but extended to all classes of the nation. The railway policy of China then, if any policy existed, was that of exclusion.

Beginning about 1879 a number of the enlightened officials began to realize the usefulness of railways. Efforts were made even at considerable personal risk, to introduce railways into the country; but the Court above and the people below were as obstinate as before. In spite of apparently insurmountable difficulties, however, the ingenious and persistent efforts of these enlightened officials gradually removed the barriers.

After the Boxer uprising, the Court became too busily occupied with other questions to maintain its opposition against railways. So for about eight years, the Government adopted what may be called a *laissez faire* policy.

By 1907, the Peking-Mukden, the Peking-Hankow, the Peking-Kalgan, the Tientsin-Pukow, the Shanghai-Nanking, the Kirin-Changchun and the Chengtai Lines had been opened to traffic. The enormous returns made by a number of these lines at once made a deep impression upon the people. They began to realize the possibilities of railways as investments. So superstition, formidable as it was, gradually gave way in the face of the increasing usefulness and earning power of railways, and in its place a railway fever set in.

The "localization" movement was started, with the slogan that each Province should race against all the rest in building all the railways within its boundaries. Many railway companies were organized. Several Provincial Governments also jumped into the whirlpool. Numerous schemes were embarked upon. Liberal rights were obtained from the Government. A considerable amount of money was raised, and a number of lines put under construction. From all appearances, there was a general enthusiasm for railway building. But the lack of practical experience in this new enterprise more than counterbalanced the force of enthusiasm, and actual railroading did not go very far.

In order to prevent these schemes from becoming complete failures and to extend the then favorite policy of centralization, which had been adopted by the young Manchu princes a few years before, the program of railway nationalization was embarked upon. This measure met with immediate and wide-spread opposition, which

*From a paper in the "Far Eastern Review."

†Chairman of the Government Commission on the Unification of Railway Accounts.

[1]After overcoming all sorts of obstacles, the first rail of this narrow-gage line was laid in 1876, exactly 50 years after the "Rocket" made its debut in England. But later opposition became so strong that the railway had to be repurchased by the Government and the rails, etc., torn up and conveyed from the mainland to Formosa to rust.

led to the Revolution of 1911 and resulted in the overthrow of the Manchu Dynasty.

As if heavenly sent for the special purpose of overthrowing the Manchus, the "localization" movement immediately subsided with the dissolution of the Dynasty. The spark which started the conflagration, the nationalization policy, however, outlived all the turmoils. This policy has since been quietly carried out until now practically all the provincial concessions are taken back.

Side by side with the nationalization program, the policy of making a system of State railways has been definitely adopted. A system of trunk lines which should be constructed and operated by the Government has been carefully mapped out. Thus the policy of creating a system of national railways began with the downfall of the Manchu Dynasty and consolidated itself during the Republic.

By the end of 1915, there were in all 8,342 kilometers of railway under operation in the country. Of these the most important is the system of Government railways, which comprises 15 different lines with a total of 5,702 kilometers, thus equalling 68.4% of the total kilometrage in the country. The second class embraces 2,399 kilometers of "concessioned" lines such as the Chinese Eastern, the South-Manchuria and the Chiaochou-Tsinan Lines; while the last class consists of 242 kilometers of private lines which are owned and operated by private Chinese companies.

This system of government railways has cost the Chinese Government $398,221,176, being about $73,783 per kilometer of line.

There are 627 locomotives of all classes which were bought from more than five different countries. A total of 823 passenger cars and 10,418 goods wagons were used in carrying the 26,036,152 passengers and 14,580,264 tons of freight in 1915. A gross revenue of 56.1 million dollars was earned, while 48 millions were spent for doing the business and paying interest on the capital, leaving $8,100,000 to the Government as a net profit during the same period. In addition to the lines under operation, there are now about 10,000 kilometers of line which are either under construction or definitely projected.

Hydraulic Principles of Flume Intakes and Outlets

By A. C. Norton*

When the velocity of water in a flume exceeds that in the canal above, there must be a sufficient drop in the intake to provide for the loss of head due to the change in cross-section of the conduit and to give the necessary acceleration to the water. The entry-head loss will depend on the shape of the transition section between the canal and the flume, which, if properly designed to make the change gradually, will reduce the entry-head loss to practically nothing. The increased velocity head is the difference between the velocity in the flume and the canal above.

The entry head and increased velocity head may be determined by the following formula:

$$h = \frac{V_1^2 - V_2^2}{2cg} \qquad (1)$$

Where h equals velocity and entry head in feet; V_1 equals velocity in the flume; V_2 equals velocity in the canal; g (32.2) equals acceleration due to gravity in feet per second; c is an experimental factor depending on percentage loss due to entry and will vary from 0.6 for abrupt entry, as when a straight head wall is used, to 0.9 where the transition is made gradually, as shown in the accompanying plans.

At the outlet where the velocity is reduced from that in the flume to that in the canal, there is a slight loss in head due to the change in section, but unless the velocity in the flume is but slightly greater than in the canal, it is not enough to take up all the difference in velocity head, and theoretically it should be possible to regain this head. Practically, however, it is possible to regain only part of this velocity head, and that only under certain conditions.

The conditions necessary for part of this velocity head to be used in regaining the lost grade are:

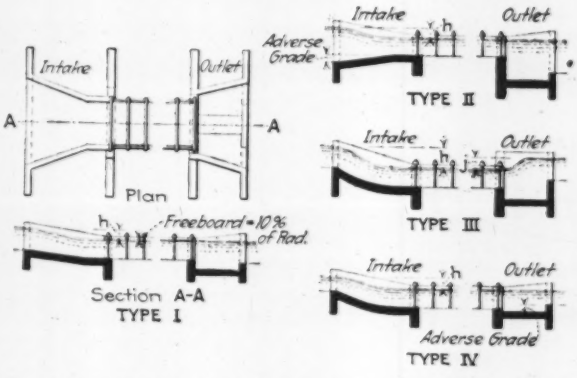
$$v > \sqrt{gd} \qquad (2)$$

and

$$s > g/e^2 \qquad (3)$$

Where d is depth in feet of water in the flume.

For smooth interior flumes, e may be taken as 100, hence the slope must be equal to or greater than 0.0032 and v, 11 to 12 ft. per sec. or over, depending on the size of the flume. To determine the height the water will rise in



FOUR TYPES OF CANAL-FLUME TRANSITIONS

the canal above that in the flume at the outlet, or what is known as jump:

$$J = -d + 2\sqrt{d\frac{v^2}{2g}} \qquad (4)$$

Where J equals the jump in feet; v equals velocity of water in the flume in feet per second; d equals depth of water in the flume in feet; g equals 32.2; s equals slope of flume per unit of length; e equals 100.

In order to be entirely safe, however, it is better to use only about half the value of J in practice.

General Plans for Transitions

These plans show the manner in which the transition between the canal and the flume may be made, also how the entrance and velocity head is provided for to gain the required velocity in the intake, formula (1).

Type I. At the outlet the water surface is the same in the canal as in the flume, except where the velocity is high enough to jump, formulas (2), (3) and (4). The main problem at the outlet is to check the velocity of the water from the flume down to that in the canal

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in such a manner as to prevent cutting and scouring the canal below the outlet of the flume. Where the velocity in the flume is high, it becomes necessary to construct some manner of check or to riprap the canal for a short distance below the flume.

Type II. This shows conditions where the depth of water in the canal is much greater than that in the flume. The maximum economy of grade is obtained by allowing only sufficient drop in the water surface in the intake to allow for h, formula (1), the bottom of the flume being higher than the top of the canal and the bottom of the intake on an inverse grade. Theoretically, this is a very satisfactory solution, but practically it is not recommended if it can be avoided, unless used in modified form.

This type of intake may work satisfactorily when clear water is used or a full head kept running, which may give enough velocity to the water to prevent the canal from silting in front of the intake. The principal objections are that as soon as the head is reduced, the velocity decreases to such an extent that it is practically impossible to prevent silting of the canal up to a level with the bottom of the flume. This may be partly overcome by placing a gate in the bottom of the canal above the intake, which will serve as a sluice and drain gate.

At the outlet, the bottom of the canal must be enough below the bottom of the flume to allow the water surface in the canal and the flume to be the same elevation, unless conditions are such that Type III outlet may be used; formulas (2), (3) and (4).

Type III. This shows conditions where the flume is carrying water under high velocity. At the intake the head h will be very large, formula (1). At the outlet, the jump may be taken advantage of providing the velocity in the flume is great enough to produce a jump; formulas (2), (3) and (4).

Type IV. Here the canal is shallower than the flume; the head h is allowed in the water surface at the intake. The outlet may be constructed on an adverse grade if the velocity in the flume is great enough to prevent silting. A gate may be provided, as shown, to drain the flume. The water surface in the flume at the outlet being the same as that in the canal unless the velocity be great enough to use Type III outlet.

Conclusions

1. The grades must be computed from the water surface owing to the differences in the depth that may exist.

2. The losses of grade consist of four quantities: (a) The loss of head at the intake due to the change in section; (b) the required velocity head at the intake; (c) the grade of the flume itself; (d) the loss of head at the outlet due to the change of section.

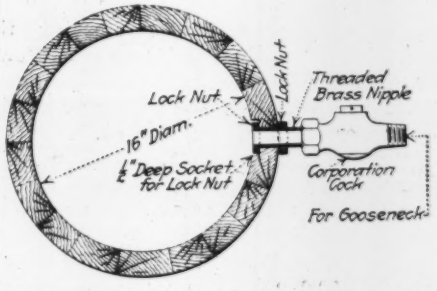
3. On short flumes, h will be much greater than the grade of the flume itself and must be allowed for two reasons; (a) in order to prevent piling up in the canal above the intake of the flume, and (b) in order to obtain the full carrying capacity of the flume.

One of the most common errors in flume construction consists in allowing all the available grade to be taken up in the flume itself, making no allowance for velocity head, consequently, the free board in the canal above the flume will be reduced until the velocity head is attained or the flume will carry only part capacity. In cases of short flumes, where a certain small amount of grade available and a large velocity head cannot be allowed, the only alternative is to increase the size of the flume and cut down the velocity even though there may be sufficient grade by allowing it all in the flume to give it a much higher carrying capacity. The grade lost must consist of both velocity head h and the grade of the flume.

Madison-Anson Water-Supply

A project, now in the course of construction, to supply two Maine water districts, Madison and Anson, probably has the distinction of being the only new water-supply development in New England at the present time. The villages of Anson, Madison and North Anson, about 80 mi. north of Portland, are to have a gravity water-supply from Hancock Pond through a pipe line 13 mi. long.

The intake is to be 16-in. universal-joint cast-iron pipe laid by a diver to a point 250 ft. from the shore line, where the depth of water is about 18 ft. The first 6½ mi. of the pipe line is 16-in. wood-stave pipe, and the other 6½ mi. is 14-in. cast-iron pipe. On account of the length of the main, three relief valves are provided to reduce water-hammer. There are a few service connections on the wood-stave main, a detail of which is shown in the accompanying illustration.



DETAIL OF SERVICE CONNECTION, WOOD MAIN

The contract cost of the main and appurtenances is $140,000 and of the distributing systems of two of the villages, $20,000. One village already has a local water-supply and distribution system. The combined population of the three villages does not exceed 5,000.

The water-supply system is designed to deliver 1,000 gal. per min. at 60 lb. pressure in the fire district of Madison, which is near the end of the line. The maximum pressure on the wood-stave part of the line is about 80 lb. All three villages have manufacturing interests, for the fire protection of which the water-supply was urgent.

In trenching for the pipe line the contractor, the Hanscom Construction Co., Boston, Mass., is using a Parsons trenching machine, probably one of the first of these machines to be used in Maine. The minimum depth of the pipe line in the woods is 4 ft. and in roadways or beaten paths 6 ft. Walter H. Sawyer, Consulting Engineer, Lewiston, Maine, who designed this water-supply, states that a covering of 2 ft. has been found sufficient for water mains in undisturbed wooded country in Maine, that the snow cover furnishes ample protection from freezing at this depth.

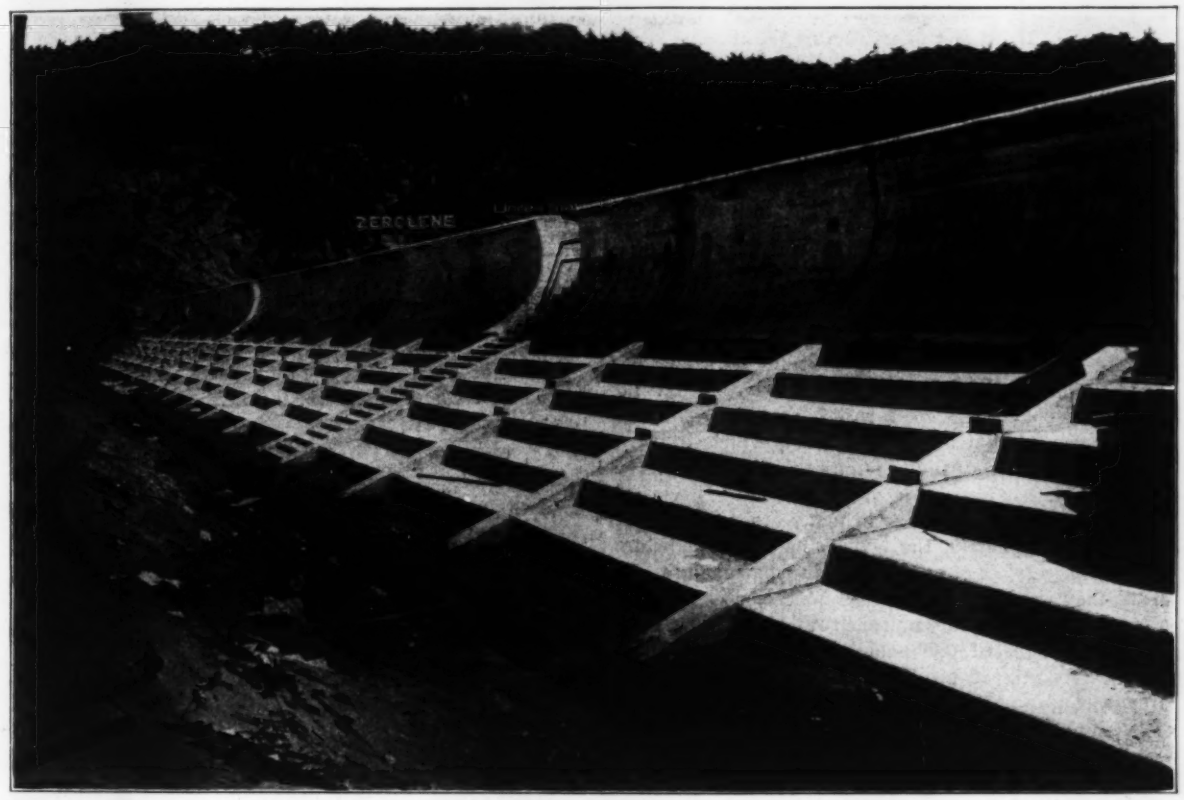
San Francisco Shore Protection Near Completion

The design of the Esplanade, now being constructed along the shore of the Pacific Ocean at San Francisco, was briefly described in *Engineering News* of Sept. 16, 1915, p. 571.

The structure is planned primarily for beach protection, having a front wall formed by driving interlocking concrete piling to a depth of 13 ft. below extreme low tide. These piles were precast, are 10 in. thick, 4 ft. wide and 20 ft. long. When in position they will form a reinforced-concrete curtain wall 10 in. thick, extending north and south. Inside of this outer line of sheetpiles are located pedestal piles 18 in. square, with 3-ft. square bulb, and 24½ ft. in length, spaced at 10-ft. centers. Between these two rows of piles are placed heavy reinforced beams 20x43 in. by 27½ ft., weighing 13 tons, which form the main tie and by means of keyways support the intermediate slabs of concrete. These beams are placed on 20-ft. centers, except at stair sections, where they are at 10-ft. centers. The space between beams is concreted to form a heavy reinforcing slab, five bleacher seats and three stringers for additional support. The stringers have a cross-section 16x18 in. The entire section between the beams has a solid bearing on sand and 18 in. of packed clay. The minimum thickness of this bleacher section is 12 in. The last bleacher riser develops into a rollway, and this rollway ends at the top of and forms part of a 3½-ft. parapet wall, with returns at either side of each stairway section. Behind the parapet is a 20-ft. sidewalk with scupper holes to release wave water and a 6-in. concrete curb and gutter.

Over the front row of sheetpiles is a heavy reinforced-concrete slab 4 ft. thick and 6 ft. wide, which caps the piles and forms a main support for lower ends of beams and intermediate slabs. At the upper end of the beams, bearing on the pedestal piles, is a similar cap that ties the upper portion of the slab and structure together. Expansion joints are provided, likewise drinking fountains and electric-light connections.

All sheetpiles, H-beams and pedestal piles were precast, allowed to season for 40 days and then put into position. Most of the precast work was done on the bank above the beach and hauled to position on cars over a construction track. Some were cast on the beach and handled directly by derrick. All piles were driven by four water jets and steam hammer.



SHORE PROTECTION AT OCEAN BEACH IN SAN FRANCISCO

Two jets of 2-in. pipe reduced to ¾ in. at the discharge end were used on each side of the sheetpiles and one at each corner of the bulb piles. In both cases they were so located that they discharged about 1½ ft. below the bottom of the pile.

Water for jetting was supplied by the Olympic Salt Water Co., under static pressure of 130 and nozzle pressure of 40 lb. per jet. Consumption of water by jetting process was approximately 100 cu.ft. per min. The steam hammer was made useful by the fact that the summer beach level is 8 ft. above the required grade on sheetpiles and if placed to required grade by jets it would be impossible to interlock the next pile. Therefore, 10 or 11 sheetpiles were placed to sand grade and

then with hammer and jets were driven to the required grade, one sheetpile always remaining at sand level to start the next pile. The bulb piles were jetted to required grade without the use of the hammer. All jetting was accomplished without very great difficulty. Floating boulders, especially at the north end of the contract, gave some trouble, making it necessary to excavate 8 ft. to winter beach level and then remove boulders. All H-beams were placed by the heavy derrick without any difficulty.

Contract for the second unit of the Esplanade was awarded in July, 1916, to J. D. Hannah for $23,148.90. This provides for an addition of 170 lin.ft. of structure, identical with that described above, so that by Nov. 1, 1916, there will be completed 670 ft. of structure. It is to be hoped that in the forthcoming budget enough money will be appropriated to finish this deserving project as far south as the chalet pile structure, built some years ago.

Design and construction of the Esplanade are under the direction of M. M. O'Shaughnessy, City Engineer.

Solving Louisiana Highway Improvement Problems

By M. C. Huckaby*

Among the first of the Louisiana communities to take up systematic road improvement was St. Tammany Parish, which is situated in the southeast corner of the state and borders on Lake Pontchartrain. The parish entered the field in the spring of 1914, by voting a bond issue of $180,000. A good roads' committee of ten members was appointed and organized, which in turn employed the writer as highway engineer to take charge of the project.

In St. Tammany Parish, as in many other sections of the state, unfortunately, the laymen had decided before obtaining the services of an engineer just how many miles of road they would build with the bond issue and, as is commonly the case, the mileage was set plenty high enough. With the $180,000-bond issue they proposed to improve 220 mi. of roads in alignment, grade and drainage.

The country being on the Gulf border, the rivers and streams through this section have to accommodate all the water that comes from the interior. Therefore the bridge item was necessarily large, and had to be made up by taking either from the width or the length of the roads to be improved.

Unusually Narrow Cross-Section Adopted

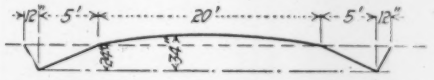
A meeting of the committee was held, and after a thorough discussion of the problem it was decided to begin the improvements on the main arteries first and to make the width between the centers of side ditches 30 ft., with a minimum distance of 20 ft. between the shoulders and a crown of 1 on 12. This being settled, the cross-section shown herewith was designed and adopted.

Throughout St. Tammany Parish the topography is uniform. In the southern portion the country is very flat, while in the northern part it is somewhat rolling. As a rule the grade line can be made parallel to the ground line everywhere except across river and stream bottoms. Therefore a cross-section was designed such that the [illegible] from the side ditches, by means of blade graders, would balance with the necessary fill for the crown.

The writer is aware that there are those who do not approve of side ditches of the shape and depth shown; it is believed by some that such a ditch is dangerous, but as yet the writer has never known of a serious accident caused by the steep slopes. On the other hand, by cutting the ditches deep a quality of material was taken from the bottom which was much better for mixing with the top soil than could have been obtained otherwise without going to much greater expense. Again, by cutting the ditches down to the depth shown, better drainage was assured. A minimum distance of 38 in. was maintained between the bottom of the ditch and the crown of the road. To date, the ditches have proved very satisfactory in keeping the roadbed drained.

For this section of the country large ditches are indispensable, owing to the fact that such large rainfalls have to be taken care of. The cross-section illustrated was used on about 100 mi. of road; a cross-section that was only 20 ft. between centers of ditches was used on about 25 mi., and out of this same bond issue about 10 mi. of state-aid road was built, which was constructed with a similar cross-section, the principal difference being that a state-aid road is 24 ft. between shoulders.

However, it will be seen that only about 165 mi. of road was constructed out of the 220 mi. proposed; but the roads were made wider, the alignment was improved more, and the grade lines were much better than the committee had originally planned for. Also several of the roads were provided with reinforced-concrete bridges and culverts.



CROSS-SECTION ADOPTED FOR ST. TAMMANY PARISH ROADS, LOUISIANA

Results Prove Economy of Design

There is excellent material for building roads at a moderate cost. The natural soil in this section of the country can hardly be surpassed for road building anywhere. In many places there is a clay foundation covered with a sandy soil of from 3 to 6 in. in depth; when taken from the side ditches and mixed and shaped in the road, this gives a good wearing surface, and that too without any extra or unusual cost for mixing other than that accomplished by the regular process of moving and placing material.

The uniformity of this natural mixture is not such that the road will run for great distances without some weak places, but by careful maintenance and adding more sand or clay, as the case may require, it will be possible to correct the weak places at a moderate cost and have the wearing surface everywhere uniform.

The traffic in this parish is not unusually dense, but the tonnage is fairly heavy. It is a lumber section, and the highways are used for logging purposes. The traffic regulations with reference to loading are practically the same as everywhere else in the South. The limitations are based on the size of the wagon and team instead of the width of tire—that is, the law allows all the load that will stay on and that can be drawn by the team.

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All the work done on the roads referred to was by contract, and the contract prices varied between the following limits on the principal items: Earth and embankment, 16 to 20c. per cu.yd.; reinforced concrete in place, $13 per cu.yd.; creosoted pine timber in place, $45 to $50 per M ft. b.m.; clearing and grubbing, $35 to $60 an acre.

There is a splendid opportunity in St. Tammany Parish to study sand-clay roads under service, and it is the intention of the writer to make such a study.

Highway-Bridge Problems

Bridge building on the highways of St. Tammany Parish is complicated by the condition of minimum fills and maximum waterways. That is, the valleys are usually wide and flat, allowing the water to spread over a large area. In several instances it is somewhat difficult to design a bridge that will have sufficient waterway without building an unusually long one or making the embankment unusually high to serve as a dam to hold the water back until it can run through the bridge opening. This latter is possible, as the current is almost negligible in every case and a rise of a few inches on the embankment would spread the overflow over a large area without material injury to property.

For the condition just described a design was made such that the depth of floor would be a minimum, thereby increasing the height of the waterway for the same grade line. The principle was used both in the concrete- and in the wooden-bridge plans. Concrete bridges were designed on a through-girder type, thus eliminating projecting beams on the bottom by using a reinforced-concrete slab (reinforcement laid both ways). A further decrease in the depth of the floor slab was made possible by using intermediate supports or short panels. For wooden bridges the panel length was reduced, the depth of the stringers was made a minimum, and the deficiency in strength was made up for by closer spacing. A minimum depth of 6 in. was used for the stringers in this design.

The foregoing conditions were common, but there were places where beam-and-girder concrete type and the longer-span types of wooden bridges could be used to advantage.

Shallow Railway Floor on Canal Bascule Bridge

By Arthur G. Hayden*

A remarkably shallow floor for heavy railway traffic makes the Franklin St. bascule bridge on the Erie Canal in Syracuse, N. Y., structurally notable. The bridge is less than two years old; it has performed successfully in all respects.

The depth of floor was limited by the maximum navigable water surface in the canal and the allowable elevation of rail. The bridge, spanning 40 ft. in the clear, carries a roadway of 34½ ft. total width between curbs and two sidewalks each 6 ft. clear width. There are four lines of main girders. The New York Central R.R. track occupies the middle roadway, 14 ft. 10 in. wide curb to curb, between the middle girders. The two roadways between middle and outer girders are 9 ft. 10 in. wide between curbs.

*Bridge Designer, Barge Canal Office, Albany, N. Y.

The two outer girders are supported on the trunnion pins and carry the bridge structure and the balancing counterweight. The two middle girders are supported on the trunnion-end floor-beam and outer-end floor-beam, but come to a bearing on the abutments at each end when the bridge is closed, so that their live-load reactions go directly to the abutments.

The floor-beams of the middle roadway are 17 ft. 3 in. in span and only 18 in. deep. They consist of a web plate 18x$\frac{3}{8}$ in. and four angles 5x3½x$\frac{7}{16}$ in. The problem of construction was to obtain a floor of the required depth giving the necessary rigidity for railroad traffic without using a ballasted trough floor, which would increase the dead weight of the bridge and add to the cost of operating machinery. The difficulty was overcome by making the railroad-track stringers continuous from end to end of the bridge by means of top flange plates passing through the floor-beam web and bottom flange plates passing below the floor-beams, thus distributing over several the loads

FIG. 1. COMBINED RAILWAY AND STREET ROADWAY OF FRANKLIN ST. BASCULE BRIDGE, SYRACUSE, N. Y.

that would otherwise come on one floor-beam. This simple expedient is shown quite clearly in Fig. 3.

The bridge was designed for Coopers E 60 loading, or four concentrations of 36,000 lb. each on the railroad track of the middle roadway, with impact allowance of 70%, an 18-ton road roller on any part of the roadway with impact allowance of 70%; 100 lb. per sq.ft. roadway and sidewalks not occupied by the concentrated loads, with impact allowance of 70%.

The roadway floor over the counterweight pit is stationary (Fig. 2), thus obviating the need of a heel lock and its operating mechanism and avoiding the precipitation of dirt into the pit when the bridge is raised. The outer main girders back of the trunnion pin descend through slots in the pit floor when the bridge is raised.

Operation of the Bridge

The machinery for operating the bridge (except motors and the rack) is located on the moving structure. The two 12-hp. electric motors, set in a machinery pit at one side of the bridge, gear to a shaft *CD* concentric with the trunnion pins. The racks *A*, which the rack pinions *C* engage, are on the curved back wall of the counterweight pit. All other machinery is placed on the moving structure, shaft *BC* with gear *C* and pinion *B* being supported by brackets from the main outer girders, and shaft *AA* with gear *B* and rack pinions *A* being supported on the girders and the concrete counterweight. This arrangement is different from that usually adopted for New York

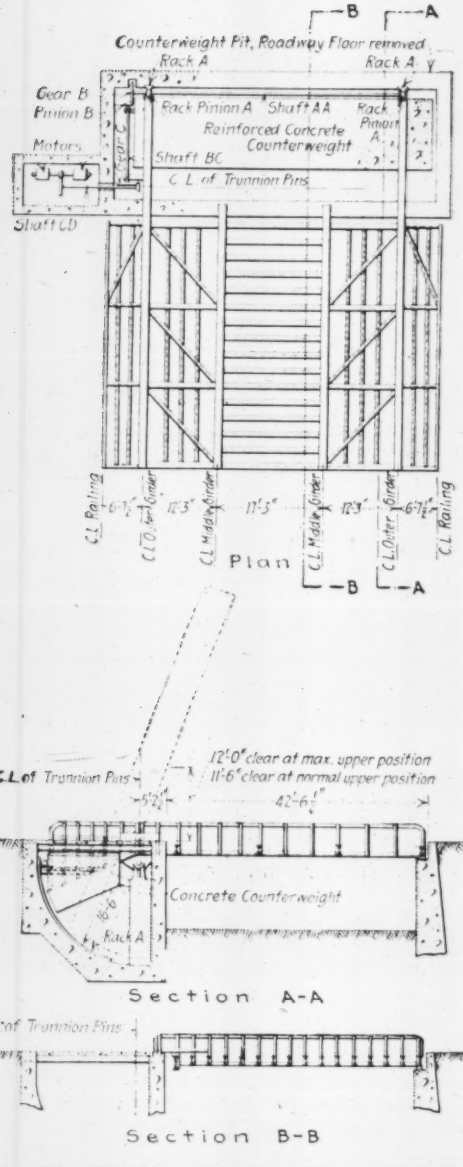

FIG. 2. STRUCTURAL ARRANGEMENT OF FRANKLIN ST. BRIDGE

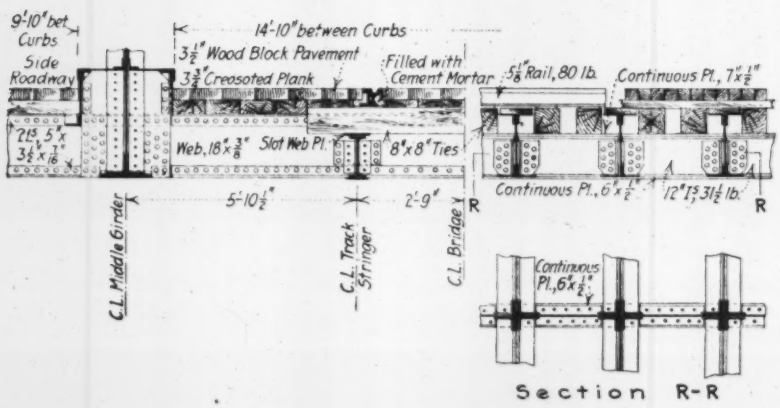

FIG. 3. SHALLOW RAILWAY-FLOOR CONSTRUCTION

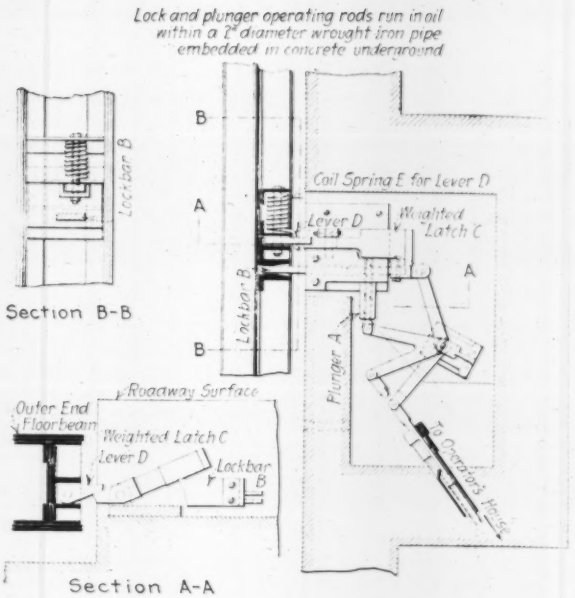

FIG. 4. TOE-LOCK MECHANISM

State lift bridges, which is to put the motors and machinery all on the concrete counterweight.

The motors are controlled by a controller of the drum type located in the operator's house near the bridge, and switches are provided so that either motor may be cut out if disabled and the bridge operated with the other motor. Each motor is furnished with a solenoid brake, mounted on the extended motor shaft, which is released with the controller on the first point. A mechanical foot brake to give the operator more complete control of the bridge comprises a band brake on the main shaft of the motors, connected with a foot treadle in the operator's house by means of rods running underground. There is provided an adjustable limit switch to stop the bridge automatically at the maximum upper position if the operator fails to arrest it in time. Wooden buffers are placed on the inside face of the first wall of the counterweight pit, which in crushing against the tail end of the moving girders will absorb the impact of the blow if the operator fails to stop the bridge in time and the limit switch and the mechanical brake all fail to act properly.

When closed, the bridge is locked at the outer end with a toe lock. The operating levers of the lock mechanism are interlocked with the railroad signal levers in a machine in the operator's house, so that they can be operated only in the following order in opening the bridge and in reverse order for closing: Two levers set the railroad signals at either end of the bridge to show danger. The setting of the signals releases the lever for operating the plunger *A*, Fig. 4, which passes through the lock bar *B*. The drawing of the plunger *A* releases in turn the lever for drawing the lock bar *B*. The opening of the lock automatically closes the main circuit for operating the bridge motors, by means of a circuit controller. The bridge can now

is raised by the motor controller. When the bridge rises a few inches the weighted latch *C* of the toe lock falls into place so as to prevent the lock bar from being thrown into place until the bridge again descends and automatically raises the latch by means of the lever *D*, the impact of which is broken by means of the spring *E*.

A circuit controller, located on the inside face of the front wall of the counterweight pit, is operated by a lever connected with the girder at the trunnion, so that as soon as the bridge starts to rise the electric current operating the railroad signals is automatically broken. This serves as a precaution (in addition to the interlocking of the signal levers with the lock-operating levers) against the operation of the railroad signals when the bridge is open.

The plunger *A* (Fig. 4) of the bridge lock is a safeguard against the operation of the signals until the lock bar is actually in place after the closing of the bridge. Without it, in case the lock bar became detached from its crank, the lock-bar lever could be thrown and the signals cleared with the bridge unlocked. But the plunger is obstructed by the lock bar. Its lever cannot be thrown, and the other operations cannot be performed.

The rods operating the bridge lock run underground in wrought-iron pipe ducts filled with oil to prevent water from seeping in and freezing. At the outer end of the bridge is attached an air buffer, fitted with adjustable exhaust and relief valves, which prevents the bridge from pounding on the abutment if the bridge in closing gets beyond control.

The bridge was designed in the New York State Barge Canal Office and constructed by the Steel Storage and Elevator Construction Co., Contractor, of Buffalo, N. Y.

Electrolytic Sewage-Treatment Tests at Durant, Okla.

One of the few plants that are treating sewage by the electrolytic process is owned and operated by the City of Durant, Okla. The promoters requested the Engineering Department of the Kansas State Board of Health to make a test of the Durant plant. A two-weeks' test was accordingly made by J. E. Welker, assistant engineer, extending from Sept. 26 to Oct. 5, 1914. An abstract of Mr. Welker's report to C. A. Haskins, engineer of the board follows, with a plan of the works.

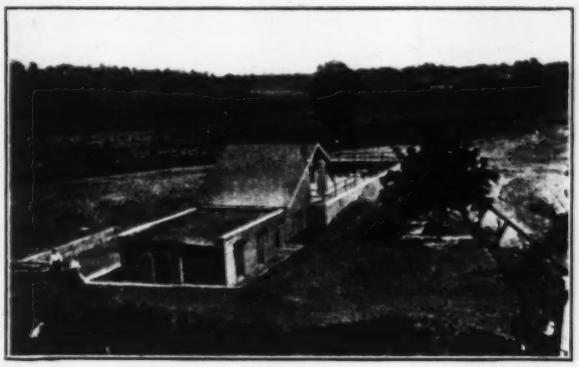

FIG. 2. GENERAL VIEW OF DURANT SEWAGE WORKS

At the time of the test, Durant had an estimated population of 7,500, but only 475 house connections. The sewage is wholly domestic, and reaches the works in a fairly fresh condition.

Preliminary to the electrolytic treatment the sewage is screened and settled. (See Fig. 1 for layout and details of plant and Fig. 2 for a general view.) The final effluent is discharged into a small brook, 100 ft. distant.

The two successive bar screens have 1- and ½-in. clear spaces and are set at angles of 45 and 30°.

The Imhoff settling tank is unusually shallow. It has a holding capacity of 100,000 gal., of which 25,000 gal. is in the digesting chamber. Sewage is admitted from a distributing trough to the digesting chamber at five points and the tank effluent is discharged over five weirs into a collecting trough.

Each of the three electrolytic troughs (Fig. 1) contains 10 sets of electrodes, consisting of 19 iron plates, 12x24x$\frac{3}{16}$ in., spaced ¾ in. apart. The troughs are baffled at the top, bottom and sides. For each trough there is a 2½-hp. generator, supplied with 3-phase alternating current at 2,200 volts, stepped down to 220 volts. The power line was not metered at the time of the test.

The amount of sewage being treated at the time of the tests, as determined by measurements on the trough weirs, was about 225,000 gal. for the 24 hr., with a night rate of 100,000 gal. The corresponding tank-retention period was 8 to 14 hr. From 5 p.m. to 7 a.m., the troughs were not used; the sewage had tank treatment only.

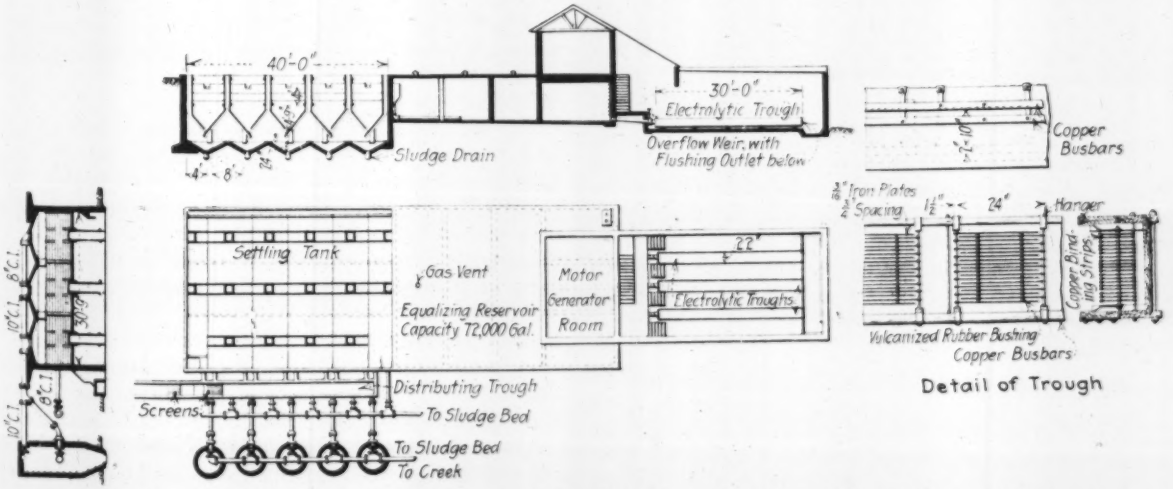

FIG. 1. LAYOUT AND DETAILS OF IMHOFF TANKS AND ELECTROLYTIC SEWAGE WORKS, DURANT, OKLA.

BACTERIAL RESULTS AT DURANT SEWAGE WORKS

Date	Time	Source of Sample*	Flow in Gal. per Day	Bacteria per C.C.† Total Count	Per Cent. Reduction‡	Volts	Amperes
Sept. 27	12 noon	Manhole	.....	900,000	.....	.....	.....
		Reservoir	.....	800,000	.....	.....	.....
		Trough 3	152,000	25,000	96.9	5.8	300
		Trough 2	53,500	340,000	57.5	4.9	200
		Trough 1	152,000	220,000	72.5	5.0	200
	6 p.m.	Manhole	.....	2,500,000	.....	.....	.....
		Reservoir	.....	1,700,000	.....	.....	.....
		Trough 3	152,000	570,000	66.5	5.6	300
		Trough 1	152,000	638,000	62.5	4.5	200
Sept. 29	11 a.m.	Manhole	.....	1,900,000	.....	.....	.....
		Reservoir	.....	2,500,000	.....	.....	.....
		Trough 1	97,200	720,000	71.2	6.0	300
	5 p.m.	Manhole	.....	1,400,000	.....	.....	.....
		Reservoir	.....	1,700,000	.....	.....	.....
		Trough 1	81,500	1,160,000	31.7	5.8	300
Sept. 30	10 a.m.	Manhole	.....	4,000,000	.....	.....	.....
		Reservoir	.....	1,600,000	.....	.....	.....
		Trough 1	81,500	67,000	96.0	5.9	250
		Trough 3	114,800	48,000	97.1	5.7	300
	4 p.m.	Manhole	.....	3,200,000	.....	.....	.....
		Reservoir	.....	2,100,000	.....	.....	.....
		Trough 1	67,000	120,000	94.3	6.0	300
		Trough 3	114,800	126,000	94.0	6.0	300
Oct. 1	9 a.m.	Manhole	.....	1,100,000	.....	.....	.....
		Reservoir	.....	1,000,000	.....	.....	.....
		Trough 1	114,800	53,000	94.7	6.0	250
		Trough 3	114,800	29,000	97.1	6.0	300
	3 p.m.	Manhole	.....	1,500,000	.....	.....	.....
		Reservoir	.....	1,200,000	.....	.....	.....
		Trough 1	152,000	392,000	67.3	6.0	240
		Trough 3	152,000	300,000	75.0	6.0	300
		Outfall	.....	670,000	44.1	.....	.....
	4:45 p.m.	Trough 2	.....	496,000	58.5	4.0	200
Oct. 2	8 a.m.	Manhole	.....	1,500,000	.....	.....	.....
		Reservoir	.....	3,700,000	.....	.....	.....
		Trough 1	.....	130,000	96.5	6.0	250
		Trough 1	114,800	40,000	99.0	.....	.....
	2 p.m.	Manhole	.....	1,500,000	.....	.....	.....
		Reservoir	.....	900,000	.....	.....	.....
		Trough 1	81,500	209,000	76.8	6.0	250
		Trough 2	114,800	510,000	43.4	6.0	100
		Outfall (35 yd.)	.....	700,000	22.2	.....	.....
		Outfall (Approx. 375 yd.)	.....	424,000	53.0	.....	.....
Oct. 3	7 a.m.	Manhole	.....	140,000	.....	.....	.....
		Reservoir	.....	1,530,000	.....	.....	.....
		Trough 1	.....	185,000	88.0	6.0	250
		Trough 2	.....	582,000	62.0	6.2	200
		Trough 3	.....	257,000	83.3	6.0	290
	1 p.m.	Manhole	.....	860,000	.....	.....	.....
		Reservoir	.....	980,000	.....	.....	.....
		Trough 1	.....	127,000	87.0	5.2	300
		Trough 3	.....	250,000	73.6	5.2	300
		Outfall	.....	690,000	29.6	.....	.....
Oct. 4	12 m.	Manhole	.....	800,000	.....	.....	.....
		Reservoir	.....	950,000	.....	.....	.....
		Trough 3	81,500	750,000	21.0	6.0	250
		Trough 1	53,500	600,000	36.8	6.0	220
		Outfall	.....	520,000	45.3	.....	.....
Oct. 5	11 a.m.	Manhole	.....	460,000	.....	.....	.....
		Reservoir	.....	280,000	.....	.....	.....
		0.4 Distance Trough 1	.....	56,000	.....	.....	.....
		Trough 3	53,500	76,000	73.0	6.0	260
	2 p.m.	Manhole	.....	800,000	.....	.....	.....
		Reservoir	.....	500,000	.....	.....	.....
		Trough 1	114,800	300,000	40.0	5.8	275
		Outfall	.....	235,000	53.0	.....	.....
	3 p.m.	Manhole	.....	450,000	.....	.....	.....
		Reservoir	.....	500,000	.....	.....	.....
		Trough 3	114,800	142,000	71.6	6.0	290
	5 p.m.	Reservoir	.....	440,000	.....	.....	.....
		Trough 1	97,200	174,000	60.5	5.6	280
		Trough 3	97,200	296,000	32.7	5.8	300

* Manhole samples were raw sewage; reservoir samples were Imhoff tank effluent; trough samples were taken at the overflow end of the trough except in the one case otherwise stated; outfall samples were composite trough samples. One of the troughs [No. 2—Editor] lacked the copper binding strips on the electrode plates, so its results were not comparable with the others and affected the outfall samples.

† On agar after 36 hr. at 40 deg. C. [Red colony counts were also made, but have been omitted here—Editor.]

‡ Figured from reservoir (tank effluent) samples. Summarizing: 95% of the tests gave a reduction of less than 97.5; 70%, less than 94; 50%, less than 78; 20%, less than 59; 10%, less than 36; 5% less than 30.

The chlorine in the raw sewage ran from 29 to 190 p.p.m., but more generally from 50 to 75. Putrescibility tests (standard methods of the American Public Health Association) showed 21% relative stability for the raw sewage on three different days; 30% and 68% for the Imhoff tank effluent on two different days; 55% and 97% after electrolytic treatment in Trough 1 on one day, 99% for Troughs 1 and 3 on one day, and 99% for Trough 3 on a third day; 99% for the outfall effluent one day but only 37% another day, when some raw sewage entered the outfall.

The bacterial log is given in the table. No satisfactory tests of the character of the effluent in the joint outfall could be made because the current was off and the troughs bypassed from 5 p.m. until 7 a.m.

In operating the troughs, the current was reversed each day to clean off the electrode plates and the troughs and electrodes were frequently cleaned by emptying the troughs and turning in a stream of water from a garden hose.

Gas formed in the troughs at all times during the test, probably due, in part, to electrolysis of the sewage. The gas would ignite with considerable force.

According to figures supplied by W. P. Danford, City Engineer of Durant, the original cost of the plant was as follows: Construction, $9,100; electrolytic equipment, $5,200; engineering and general expenses, $1,200; total, $15,500. On the basis of treating 100,000,000 gal. of sewage a year Mr. Danford estimated (in 1914) the operating costs per 1,000,000 gal. as follows: Purchase of current (including lighting) $6.40; attendant, $7.20; incidentals, 20c.; renewal (once a year) of copper strips, 60c.; total, $14.40.

Mr. Welker summarized his study of the plant as follows:

Samples of final effluent were practically odorless after being bottled and allowed to stand at room temperature for a period of several days. After a longer period, some putrefaction did take place in the bottled samples. It was impossible to make a satisfactory study of the conditions existing in the outlet brook below the plant, due to the entrance of raw sewage for a part of the time. However, no nuisance was created for a considerable distance below the plant, which the writer inspected.

The final effluent showed a high relative stability, as indicated by methylene blue putrescibility tests.

No relation could be found between the bacterial reduction and the energy used, or between the reduction and flushing, reversing current or hosing out of troughs. In general, the lower the bacterial content of the effluent from the settling chamber, the lower the percentage reduction of bacteria in the troughs.

Municipal Shops at San Diego

By Francis M. Lockwood*

The assembling of San Diego's machine shop followed closely the establishment, in May, 1915, of the City Manager scheme of government and the appointment of a Manager.

With the placing of the different departments of public works under one head, the plan of consolidating the shops and yards of the Street, Water and Sewer Departments was conceived and put into effect. Some 2½ acres of ground that had been used by the Street Department was utilized for this purpose, and with the addition of the meter-repair shop, which was moved from the Water Department yards, and the alteration and remodeling of the buildings already located on this plat a very adequate municipal shop and yards was fitted up. Fig. 1 is a view of a portion of the yards, and Fig. 2 is an interior view of the machine shop.

The machine shop occupies a position about a block back from the entrance to the yard, in the rear of which is an acre of ground used for corrals for the stock. This building is 50x100 ft. in plan and is used as a machine shop, automobile-repair shop and blacksmith shop. It is equipped with two lathes, a 6- and a 10-ft., with a swing of 16 in. It has also two drill presses, two trip hammers, two emery wheels, shears and punch and a tire bender. On the second floor is the carriage and carpenter shop, with its rip and cutoff saw and planer. A paint shop adjoins the machine shop in the rear at one end and a horseshoeing shop at the other.

All machine work that can be handled with a 16-in. lathe, all automobile repairing, blacksmithing and horse-

*Secretary, Operating Department, San Diego, Calif.

...ooing for the city are done at this shop. Pump repairs, ...pairs to dredges and other machinery used at the harbor, ... well as carpenter work, are also handled here, the work ...ll being under the supervision of a Master Mechanic.

This shop is self-sustaining, charging the different bureaus for work done, but only at the actual cost of material and labor furnished. In addition to the money saving accomplished on the machine work, which is estimated at 35%, a greater saving is made in the department's being enabled at all time to secure the services of a first-class mechanic for emergency repairs without experiencing the delays so often encountered when outside machine shops have to be depended upon.

Eleven Ford runabouts used in the department have been standardized, each being fitted with a bed for carrying tools and materials and all painted a uniform color with the city's label attached. A saving of 50% is made on automobile repairs, and the painting is done at a saving of 33⅓%.

FIG. 1. PART OF MUNICIPAL YARD, SAN DIEGO. STREET DEPARTMENT BARN ON RIGHT; STORAGE SHED ON LEFT

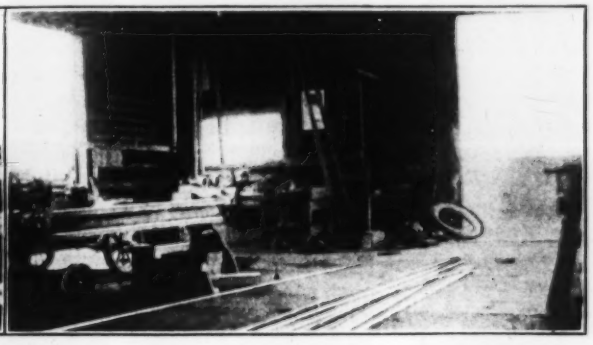

FIG. 2. MUNICIPAL MACHINE SHOP, SAN DIEGO, WHERE A SAVING OF 35% IS EFFECTED

Opposite the entrance and extending down the middle of the yard is a long shed with a 50-ft. driveway on either side, which is used for storage of street sprinklers and sweepers and for a pipe rack. Each end is inclosed, one being used as a storeroom for the purchasing bureau and carrying a stock of approximately $70,000, the other being fitted up as an office, having desks for the Master Mechanic and the superintendents and clerks of the street and water bureaus.

At the right of the entrance a two-story house is occupied by the emergency crews. Extending from this to the machine shop is a shed utilized for oil and gas tanks, for toolrooms for the water and sewer bureaus and for a meter shop. All meter repairs are attended to here, and a cement meter box is also being made which replaces the old wooden meter boxes as fast as they become useless. This concrete meter box is built for 43c., a saving of 100% over the wooden box with iron cover, and its life is practically endless.

At the left of the entrance is the Street Department barn, with stall room for 65 head of stock and storage room for 300 tons of hay. Adjacent is space for storage of dump wagons, etc., and beyond is the broom shop, where broom cores for the rotary sweepers are filled and push brooms for the "white wings" are made. These brooms, in addition to being of a quality superior to any the market affords, are made 50% cheaper than they can be obtained. The Street Department toolroom is also situated here and a building for storage of heavy machinery.

Steel Sheetpile Coffer-Dam for Lock on Cape Fear River

A steel coffer-dam of the pocket type was used in the construction of Lock No. 2, Cape Fear River, North Carolina. This work is described in the September-October issue of the *Professional Memoirs* of the Corps of Engineers, U. S. A., and the Engineer Department at Large; the work was similar to that described in the first article of this week's issue, at Troy, N. Y.

For the Cape Fear River lock double rows of Lackawanna sheetpiling, connected at intervals by transverse rows, were driven around the lock site. The pockets thus formed were of such dimensions that when filled with earth they could resist the unbalanced pressure on the coffer-dam without support. As the steel on the land side was driven well back into the river bank, where the ground was level with the tops of the pockets, no filling was necessary on that side; the river pockets were filled with material dredged in the coffer-dam inclosure.

The pockets were of two types. Those at the upper end had parallel inside and outside walls tied together by walings and steel cables and rods. The other pockets were without ties, the inside wall being curved to reduce distortions in the steel piling caused by the filling.

Driving requirements and limited space for plant made necessary two single-wall panels in the upper and lower wings. These panels were held by cables to wooden pile anchorages.

Arched-web piling, on account of its greater transverse strength, was used in the walls held by walings and on the outside of the river pockets; straight web piling was used in the interior curved walls, the cross walls, and on the outside of the land pockets. The total length of the coffering was 878 ft.

The elevation of the top of the steel above mean low water was 23.4 ft. This elevation corresponded to an average height above the river bottom of 28 ft. The lock floor was laid before pumping out so that the coffered inclosure, after pumping out, had a depth of 31 ft.

The controlling conditions were: A narrow river, requiring a coffer-dam which would obstruct the river as little as possible; a poor foundation, which made it desirable to seal the bottom before pumping out, and a considerable head of water to take care of. The river is subject to rapid rises, which completely submerged the coffer-dam. A 24-in. pipe through one of the pockets, 12 ft. below the top, provided for flooding the coffer.

Engineering Literature

Reviews of Technical Books

By R. Fleming*

The question, "Did you ever hear of anyone except the author, the reviewer, the author's wife and the publisher's advertising man who had really read a book review?" asked a few months ago by a "reformed book reviewer," does not apply to technical books. Purchasers of technical books for libraries are guided largely by book reviews. Engineers isolated from their fellows are obliged to decide from reviews what books they shall purchase. The Technology division of the New York Public Library publishes lists of technical books that have been added to the library. Following the titles and descriptions there are references to the papers in which the books have been reviewed. Extracts from one or more reviews are often given. The demands of public and technical libraries may require no small part of the first edition of a book if it is favorably reviewed. The importance of the review is thus readily seen.

A good book review should be clear, concise, fair and accurate. The scope of the book, its value as a whole, any special features that are brought out, and to what class of readers it is valuable should be stated. That no injustice may be done to the author the reviewer should have an adequate knowledge of the subject reviewed. It is often difficult to be fair to seller and buyer, the publisher and the reading public. If true to his convictions, the reviewer must sometimes say disagreeable things.

The story is an old one of the critic who always wrote his reviews before reading the books, "because reading prejudiced him so." Are technical books reviewed without being read? Sometimes. What can be done with the preface, the table of contents and the publisher's announcement is surprising. Generalities thus take the place of definite statement. An abstruse book on mathematics was once handed to a nontechnical man for review. After floundering around he concluded with, "They that like this sort of thing will find in this book something that they like." Two or three years ago a book treating of a subject upon which little had been written went the rounds of the technical papers for review. It had grievous faults, but was not condemned because reviewers were unfamiliar with its subject. They passed upon it in language similar to that quoted, but not so frank.

Unworthy books are sometimes foisted on the public by extensive advertising and extracts from reviews in the so-called "popular" science and technical periodicals. These reviews are often by men who write glibly on subjects of which they know but little. Again, the indorsements of college professors of standing are obtained in some way and widely flaunted. How Prof. —— of —— and Prof. —— of —— can recommend —— in the terms they do is beyond the writer's comprehension.

The signed book review is the great promoter of efficiency in book reviewing as well as a corrective of evils. A man writing over his own name gives more thought to his statements and is chary of writing about things with which he is not acquainted. The fact that there is a name attached gives greater weight to the opinions expressed and locates responsibility. The practice of having book reviews signed is followed by the leading technical periodicals, and the practice is increasing.

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Making Engineering Libraries of Greatest Benefit

Librarians are beginning to appreciate that the engineering profession constitutes no small part of their clientele, and they are discussing ways and means for satisfying the demands of those who seek specialized technical information. This is the express object of the Special Libraries Association.

To be of the greatest use to engineers the existence of the association must be known to them, and it must have their active coöperation, or at least the coöperation of such of them as are qualified to offer suggestions and support. The following extract from a paper by Kenneth C. Walker, of the Department of Technology of the New Haven Public Library, makes a plea for coöperation, not only of engineers, but of libraries:

> The first step is not new to the library field and is very much in the air. It is the assignment of libraries already strong in one subject, the sponsorship of that subject. This subject of sponsorship needs no enlargement.
>
> Having our roster of sponsored libraries, the next step is to publish this list and distribute it widely and to the most effective places. Perhaps I should say here that, with these sponsored libraries, suitable subsponsored libraries, or agencies distributed regionally, should be made effective in order that the maximum convenience and accessibility be accomplished.
>
> The next problem is to educate the clientele in the use of library service. W. P. Cutter, in his paper on "The Technical Library's Field of Service," read at the October meeting of this Association says: "This is the most difficult step; for unless you can find out very specifically what a man wants you will not only waste your time in looking up information which is not wanted by the client, but you make him skeptical of your ability to help him. . . . Be sure therefore that you know what is wanted."
>
> A problem connected with smooth and efficient operation of the sponsored libraries is that of standardization. This would include the standardization of interoperation; further the standardizing of operations of frequent occurrence. Standardization would not only promote unification, which is most desirable, but would permit of detail work being done by assistants, thereby leaving for the work of the librarian the work of the executive—creating and directing.
>
> Little or nothing has been said of the person in charge of these sponsored collections. By virtue of the fact that certain collections have been assigned a given sponsorship, it is to be supposed that the executive of such a collection is an able person. These executives to my mind must be more than catalogers, classifiers and reference workers; they must be what C. B. Fairchild, Jr., has aptly called the future special librarian—the consulting analyst.
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> Any undertaking cannot be successful without making itself known to all it is intended to benefit. In other words, whatever the outcome of this paper may be, publicity must play an important part.

The engineering societies of the country, as well as wide-awake individual engineers, can aid in the needed publicity work, and take advantage of the services which the public libraries are offering to help them.

REVIEWS AND NOTES

Water-Works Engineering

REVIEWED BY CALEB MILLS SAVILLE*

WATER-WORKS HANDBOOK—Compiled by Alfred Douglas Flinn, M. Am. Soc. C. E., Deputy Chief Engineer, Board of Water-Supply, New York; Robert Spurr Weston, M. Am. Soc. C. E., Assistant Professor of Public Health Engineering, Massachusetts Institute of Technology, Consulting Sanitary Engineer; and Clinton Lathrop Bogert, Assoc. M. Am. Soc. C. E., Assistant Engineer, Board of Water-Supply, New York. New York: McGraw-Hill Book Co. Leather; 6x9 in.; pp. ix + 824; 411 illustrations. $6 net.

Recently two very notable publications on sanitary subjects have been presented to the engineering profession. The first of these was the three-volume work by Metcalf and Eddy, "American Sewerage Practice," and the second is the "Water-Works Handbook" just out under the authorship of Messrs. Flinn, Weston and Bogert. To those who knew of the forthcoming of this book its appearance was awaited with an eagerness that was found not to have been misplaced when the book was at length received.

To those water-works men who know of the book only from press notices that have appeared since its publication it may be said safely that it is a working tool which fills a long-felt need in its particular province. This book is unique in its presentation of water-works facts, and many of the data contained, especially in the first and middle parts of the book, are from original sources and now available for the first time.

It is a practical book for practical men, compiled with care by able practicing engineers. It is not a textbook in any sense of the word, and yet no college technical course in sanitary science can now be complete without frequent reference to the facts and data which have been taken so generously from the personal notebooks of the authors.

As a general proposition the word "handbook" means a collection of heterogeneous data which often are thrown together with little attempt at classification and slight explanatory matter to aid in their application to special problems. This phase is noticeably absent from the present book, and he who reads carefully will find something here to aid in almost any difficulty.

The book is divided essentially into three principal sections—First, "The Supply of Water"; second, "Its Distribution to Consumers"; and third, "Its Treatment To Provide a Safe and Clean Water."

In the first section there are three parts—Part I. "Sources," comprising chapters on "Rainfall," "Evaporation," "Runoff and Ground Water"; Part II. "Collection," with chapters on "Intakes," "Watershed Development," "Reservoirs," "Dams of Masonry," "Earth and Rock Fill," "Wells" and "Infiltration Galleries" and "Notes of Equipment for Treating Water"; Part III. "Transportation and Delivery," containing chapters on "Open Channels," "Aqueducts," "Metal, Wood and Concrete Pipes."

In the second section there are twelve chapters devoted to "Cast-Iron Pipes," "Distribution Systems," "Valves, Gates and Hydrants," "Service Meters," "Pumps and Pumping Stations," "Distributing Reservoirs," "Standpipes and Tanks," "Water Consumption," "Hydraulic Computations," "Masonry and Puddle," "Nonferrous Metals," "Corrosion of Iron and Steel," "Conversion Tables" and a "Miscellany" of unclassified general data.

The third section, which is given over to the "Character and Treatment of Water," contains nine chapters—"Character of Water," "Inspection of Sources of Supply," "Storage of Water and Improvement of Reservoirs," "Sedimentation," "Aëration and Chemical Treatment," "Water Softening," "Preliminary Filtration and Deferrization," "Filtration" and a final chapter on "Examination of Water."

In general, the first section, comprising 378 pages, contains data of remarkable value; the second section of 265 pages includes much useful information very well arranged; the third section of 160 pages in comparison with the others is rather disappointing in that the chapters are brief and either omit or only mention some of the newest thought in water-works treatment.

As a whole, the subjects of the chapters are well selected and logically arranged. The book is thoroughly and carefully indexed in 21 pages, references to more extended treatment of subjects are freely given, the diagrams generally are well chosen and drawn, and the tables are excellently compiled. The book appears in attractive semi-flexible covers; the printing and paper have been chosen with care to avoid fatigue to the eye.

Many of the data undoubtedly could be found elsewhere in special treatises, technical publications and in reports after more or less patient search. So far as the reviewer is aware, however, there is no other book that so logically gathers together this matter and presents it in such great detail, stripped of nonessentials, ready for use by the busy water-works practitioner.

With a book so varied in its subject matter it is possible to give only the briefest survey of its contents. Beginning with the subject of rainfall, statements are made of general applicability, followed by tables of selected long-term rainfall and temperature records covering the entire country. These are amplified by diagrams showing typical relations between intensity and duration of rainfall under maximum rates.

The subject of evaporation is well treated, giving usable data based on results from various parts of the United States, and includes much new matter from recent Weather Bureau research.

In the chapter on runoff great stress is laid on the necessity for proper data, and the principal requirements are shown. The rather long description of current-meter mechanism could well have been replaced by a very brief statement and a sentence or two added concerning the several types of meters and their special applicability. The subject of watershed development is exceedingly well treated and contains a vast fund of very useful information.

The chapter on masonry-dam construction is particularly valuable on account of the data drawn from the exhaustive studies made for the work of the New York water-supply. Especial mention may be made of the information presented on the effect of upward pressure and ice and temperature effect. Dams and weirs on porous foundations are treated in some detail, much of the matter being drawn from the admirable monographs of W. G. Bligh on this same subject. The chapters on earth and rock-fill dams seem hardly to have received as much attention as could be desired, in view of the importance of such structures in ordinary water-supply development.

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The chapter on wells is particularly full and brings into convenient form much very useful information that might be easily overlooked in a casual search. The chapter on infiltration galleries is rather brief, but the references are particularly complete and undoubtedly give adequate details.

The chapters on the transportation and delivery of water are very well written and crammed full of data and information. The investigation work along the lines of this subject by the New York Additional Supply Board was especially complete, and the results here given will be highly appreciated by water-works designers.

The chapter on plate-metal pipes might with advantage have included more data on durability and conditions under which such pipes can be used to best advantage. The chapter on pumps, pumping stations and equipment is excellent, and the data given are quite complete.

The chapter on hydraulic computations is especially rich in ready-to-use diagrams and tables for solving ordinary water-supply problems, as well as giving exceptional data for advanced investigations. Much valuable information is brought together in the chapter on nonferrous metals, and the paragraph on the cracking of brass or bronze especially is of timely interest.

The third section of the book, on "Character and Treatment of Water," brings together in usable form much information hitherto scattered in many places. The data in the chapters on character of water, storage of water and improvement of reservoirs are of particular value in their references to American water-supply.

The chapter on aëration and chemical treatment is quite complete, as is also that on water softening. The chapter on filtration is rather brief, the most useful data being the cost of various plants and methods of operation.

To sum up, the "Water-Works Handbook" meets the needs of the designer of water-works systems and also contains most valuable information and suggestions for the water-works operator. The facts are stripped of technical detail and set down in plain language. It is not a treatise on water-supply, but is exactly what it purports to be, "a usable compilation of information, old and new, for the water-works engineer and superintendent, the designer, constructor, operator and inspector."

In its sphere it is undoubtedly one of the most valuable books on water-supply subjects which have appeared, and there is every reason to believe that it will be one of the "best sellers" from the technical press.

Laws To Regulate Competition

TRUST LAWS AND UNFAIR COMPETITION—By Joseph E. Davies, Commissioner of Corporations, Department of Commerce. Paper; 6x9 in.; pp. 832. 40c.; sold by Superintendent of Documents, Government Printing Office, Washington, D. C.

Hon. Joseph E. Davies, the author of this book, was formerly a prominent attorney of Madison, Wis., but four years ago was appointed Commissioner of the Bureau of Corporations and later was made Chairman of the Federal Trade Commission, which succeeded to the work of the Bureau. His book reviews the present Federal and state antitrust laws and laws covering various methods of unfair competition, with judicial decisions thereon. It has been said with truth that the laws which have been made to prohibit the organization of trusts have not prevented the further consolidation of industrial enterprises. On the other hand, examination of Mr. Davies' book shows that these laws have had a material effect in limiting improper business practices and combinations tending to monopoly. Mr. Davies' review includes not only American legislation and court decisions but laws of foreign countries dealing with the same subject.

Three Books on City Planning

THE PLANNING OF THE MODERN CITY: A Review of the Principles Governing City Planning—By Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment of New York City. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xv + 423; 62 text illustrations and 87 plates. $3.50 net.

CITY PLANNING, With Special Reference to the Planning of Streets and Lots—By Charles Mulford Robinson, author of "Modern Civic Art," "The Improvement of Towns and Cities," etc. A reissue, revised, with much additional material, of the work originally published under the title of "The Width and Arrangement of Streets." New York: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. xiv + 344; 58 illustrations. $2.50 net.

CITY PLANNING: A Series of Papers Presenting the Essential Elements of a City Plan—Edited by John Nolen, Fellow, American Society of Landscape Architects. New York: D. Appleton & Co. [National Municipal League Series.] Cloth; 5x8 in.; pp. xxvi + 447; illustrated. $2 net.

Three books on city planning, each from a different viewpoint—one of them, in fact, from many viewpoints—coming off the press as nearly together as these three certainly attest a lively interest in the subject. Each volume is good, in its own proper way, and only to a minor degree are the books competitive.

In the volume on "The Planning of the Modern City," by Nelson P. Lewis, we have the first really American book on city planning written by an engineer for engineers. This does not mean that the volume will not be eminently useful to the architects and landscape architects from whose ranks most of the other books on city planning have come. It will be decidedly useful to them. It will also appeal to laymen who, though deeply interested in city planning, feel that most of the architects and landscape architects are carried away by their devotion to the æsthetic side of the subject. As Mr. Lewis well says in his introduction, "the fundamental problems of city planning are, and from their very nature must be, engineering problems."

The author describes the aim and method of his book as an attempt "to show by a few concrete examples what has already been accomplished, rather than to indicate just how the several problems should be attacked or solved." These examples are too modestly characterized as "few."

After introducing his subject, Mr. Lewis outlines the elements of the city plan, which are (1) transportation, (2) the street system, (3) parks and recreation facilities and (4) the location of public buildings. All four of these he considers as engineering problems, devoting a chapter to each. The need and economic value of a city plan and the industrial plan or district are next considered. A return is then made to streets and transportation, with special relation to street traffic and details, and to the railroad in its relation to the street system. Building restrictions, city environs, garden cities, legislation, methods and progress, financing, land policies and, finally, "The Opportunities and Responsibilities of the Municipal Engineer" are taken up in succession.

In the chapter whose title has just been quoted Mr. Lewis truthfully says:

> The engineer as the first man on the ground has a rare opportunity and a grave responsibility. The task calls for vision and imagination, and these are qualities the exercise of which on the part of the engineer has often been thought

rather dangerous; and yet the engineer lays the foundations upon which our cities are built. He has been too prone to regard his preliminary work as a mere matter of surveying; more or less precise surveying, it may be, but he has been more intent upon the accuracy of his measurements of lines and angles and of his computation of areas than upon the larger problem of providing for the orderly and sightly development of the city.

This broader vision Mr. Lewis' book is well designed to give. The well-chosen and admirably presented illustrations will aid in making the vision clear.

The name of Charles Mulford Robinson is well known in America and England to all who have given much attention to city planning, both through his books and his many city-planning reports. The book now before us, in smaller compass and in a more modest but very useful form, appeared a few years ago as "The Width and Arrangements of Streets" (reviewed in these columns Dec. 14, 1911). The material there given has been rearranged and extended under these three main heads: (1) "Standardization in Street Platting," which is broad enough to include both the economic and social defects of standardization; (2) "Functional Street Platting," which comprises the body and fulfills the main object of the book, and (3) "City-Planning Legislation," a fifty-page review of attempts at control, excess condemnation, methods of street widening and the zoning or districting system.

Under (2) many phases of street planning are considered, taking into account the various classes of streets in relation to traffic and use, as well as lot platting and public reservations of land other than for use as streets.

Mr. Robinson's book is unique in that he has chosen an element—a large and fundamental one—in city planning and treated it systematically and in considerable detail. He shows more restraint than in his "Modern Civic Art" and many of his city-planning reports, which were too pronouncedly æsthetic in aim and expression for the average prosaic and rather suspicious American citizen and taxpayer who must pay the city-planning bills.

The volume is fittingly illustrated and well made generally.

Under the leadership of John Nolen, himself a past master in city planning and landscape work, fifteen specialists in city planning and related subjects have collaborated in producing a handbook entitled "City Planning." The book is designed for "the more serious and responsible part of the general public" that wishes information on the subject "in compact and readable form," and also for students and practitioners of the art who wish "a convenient summary of American experience and an embodiment of good methods and practice."

A partial but fairly good idea of the wide scope of the volume and the competency of the list of contributors may be given by the following selection from the contents: "Introduction," F. L. Olmsted; "Subdivision of Land," John Nolen; "Public Buildings," Edward H. Bennett; "Park Systems," John Nolen; "Water Supply," Caleb M. Saville; "Navigable Waters," E. P. Goodrich; "Railroads," George R. Wadsworth; "Transportation," Benjamin A. Haldeman; "Rapid Transit," John V. Davies; "Fundamental Data," George B. Ford; "Financing," Flavel Shurtleff; "Legislation," Charles M. Robinson. At the end of the each chapter there is a special bibliography and at the end of the book a general bibliography.

The book deserves a wide general circulation among students of city planning—whether in school or in civic life—and will be valued by specialists for bringing together so much material from the pens of so many city-planning workers. It is a pity that so many of the line drawings and lettered wash drawings were reproduced without first being properly relettered to size and style suitable for photographic reduction. As a result, much of the lettering is illegible.

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Revised Edition of Harbord and Hall's Metallurgy

REVIEWED BY WILLIAM CAMPBELL*

THE METALLURGY OF STEEL—By F. W. Harbord, Assoc. R. S. M., F. I. C., formerly Consulting Metallurgical and Analytical Chemist to the Indian Government, Royal Indian Engineering College, Coopers Hill; and J. W. Hall, Assoc. M. Inst. C. E., Consulting Engineer, Birmingham. (In two parts.) Vol. I, Metallurgy. By F. W. Harbord. Vol. II, Mechanical Treatment. By J. W. Hall. Fifth edition, enlarged and revised. Philadelphia: J. B. Lippincott Co. [Griffin's Metallurgical Series.] Cloth; 6x9 in.; pp. xvi + 522 and xviii + 411; 54 folding plates, comprising 115 figures, over 500 illustrations in text and nearly 80 photomicrographs of steel sections. $12.50.

The fourth edition of this work appeared in 1911. The main changes occur in the chapters on the Theory of Hardening Steel and on Alloy Steels, which have been brought up to date. The second volume on the Mechanical Treatment of Steel, by J. W. Hall, remains the same. As a textbook on the Metallurgy of Steel, these two volumes retain their place in the first rank and deservedly so.

Discussing the various theories of hardening, we have now the Stress Theories (p. 362). According to Carpenter and Edwards, on quenching steel severe stresses are set up which cause very pronounced crystal twinning. At all surfaces of slip on which twinning occurs, amorphous layers are found. *"We consider that the ultimate cause of hardening by quenching steels is the presence of these amorphous layers."* It follows that the final cause of hardening by quenching is exactly the same as by cold work—the interval deformation of crystals. According to M'Cance's interstrain theory of hardness (p. 365), in a quenched and uniformly hardened steel the carbon is in the state of solution, and it retains a portion of the iron in the gamma condition—the proportion increases very rapidly with the carbon content. The majority of the iron is, however, in the alpha condition, but owing to the restricted mobility during the period of quenching, the crystalline units are not homogeneously oriented, and the hardness of steel is due to this condition, which is similar to that of interstrain. According to Humfrey hardening is due to the presence of a hard amorphous solution of alpha iron and iron carbide, which solution can be compared with Beilby's amorphous phase due to overstrain.

To the chapter on alloy steels, Guillet's diagrams showing the constitution of chrome, manganese and nickel steels have been added. Alloy steels are now industrially so important that 33 pages is all too short to devote to them. Reference might be made to the works of Marz and Becker, and a well-chosen bibliography would be of great value.

It is stated that the way in which carbon diffuses in cementation is still a matter of discussion (p. 246). Yet after reading Giolitti's book on "Cementation of Iron and Steel" there seems little room for much discussion.

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Similarly in Chapter XV (p. 341) the various researches showing the relation of carbon and iron, which are mentioned, have been admirably dealt with by Giolitti. The omission of reference to Wittorf's diagram with Fe_4C and FeC_2, also Upton's diagram with Fe_6C and Fe_2C, is noticeable.

Two or three minor criticisms occur. As an illustration of a modern openhearth plant, the 1898 plant at Homestead is given. Gary or the new Edgar Thomson would be better. Again, Chapter XII on armor plate could be improved. Plate for the United States Navy is stated to contain 3.25% Ni and good Krupp plate Ni 3.5: Cr 1.5: Mn 0.7: C 0.3%. Yet it is generally understood that the Navy uses nickel-chrome-vanadium.

Under the heading of the Duplex Process (p. 204), "Various attempts . . . have not been attended with great success" hardly applies to this country; for several of our large plants are duplexing most successfully.

In conclusion we may say that Harbord and Hall's Steel holds the place in advanced textbooks that Stoughton's iron and steel holds in elementary texts and is well worth the reading.

A Tribute to Colonel Gaillard

DAVID DuBOSE GAILLARD: A Memorial—Compiled and published by the Third United States Volunteer Engineers, St. Louis, Mo. (1718 Pierce Building): Luther Ely Smith, Secretary, Third United States Volunteer Engineers Association. Paper; 6x9 in.; pp. 188; illustrated.

The Third Regiment of United States Volunteer Engineers served during the Spanish War under the late Col. David DuB. Gaillard as commander. Following Colonel Gaillard's death in December, 1913, members of the regiment at their annual meeting held in St. Louis in the following May decided to compile and publish a memorial volume in honor of their former commander. In this volume have been brought together many tributes to Colonel Gaillard's work as an engineer and as a man which appeared at the time of his death, and accounts of his life and professional achievements. The paper on "Gaillard as an Engineer" was prepared by Col. Edgar Jadwin, who served with Gaillard on the Isthmus.

Petroleum on Public Lands

PETROLEUM WITHDRAWALS AND RESTORATIONS AFFECTING THE PUBLIC DOMAIN—By Max W. Ball. Compilation by Lucetta W. Stockbridge. Washington, D. C.: United States Geological Survey. Bulletin 623. Paper; 6x9 in.; pp. 427; 9 folding plates in separate cover.

This bulletin contains an elaborate record with maps and published correspondence, concerning the withdrawal from entry of oil lands in the public-land states. There is a prevalent idea that the principal motive of the Government in withdrawing the lands from entry was to prevent the giving away of natural resources of great value and to save the underground stores of oil for use by future generations. This bulletin explains that the Government stepped in to save the oil industry from impending ruin, as well as to check the vast waste that was going on. The placer law, under which all oil development on the public lands is carried on, practically forces the owner of oil-bearing land to drill for oil or run the risk of losing his land. Further, after he has drilled and found oil, the law practically forces him to exhaust the deposit at the quickest possible rate lest his adjoining neighbor put down a well and take the oil away from him. The present law thus practically compels over-production of oil. This over-production and the methods by which the drilling is carried on result in an enormous waste of this valuable fuel, and it was deemed best therefore to withdraw from entry all the oil-bearing public lands until Congress shall pass a new law to supersede the present statute and remedy conditions which are universally agreed to be bad.

Industrial Chemical Processes

OUTLINES OF INDUSTRIAL CHEMISTRY: A Textbook for Students—By Frank Hall Thorp, Ph.D., with Assistance in Revision from Warren K. Lewis, Ph.D., Professor of Chemical Engineering in the Massachusetts Institute of Technology. Third revised and enlarged edition. New York: The Macmillan Co. Cloth; 6x9 in.; pp. xxv + 661; 137 illustrations. $3.25 net.

Professor Thorp's teaching text on chemical processes in industrial services has been favorably known for years, but of late has necessarily been inadequate owing to the great strides of industrial chemistry since the 1905 edition. The new book follows the general scheme of the old one, but differs in detailed presentation and is more extended in scope. Great technical detail is not presented, the author relying on his selected bibliography to guide the student and casual seeker to more extended discussions. The wide range for such a moderate-sized volume precludes the possibility of mathematical treatment of phenomena involved.

The book begins with the more general and fundamental processes, evaporation, distillation, filtration, calcination and refrigeration. Then some properties of materials—such things as fuels, waters, sulphur, acids, salts, chlorine, lime and cements, glass, cyanides, wood, tar, mineral oils, oils and fats, soaps, resins, starch and glucose, yeasts, explosives, fabrics, paper, glue, leather and metals—are interspersed between notes on the processes that produce or utilize them.

Railway Specifications

SOME FOREIGN SPECIFICATIONS FOR RAILWAY MATERIALS: Rails, Wheels, Axles, Tires—By G. K. Burgess, Physicist, and P. D. Merica, Associate Physicist. Washington, D. C.: Bureau of Standards. Technologic Paper No. 61. Paper; 7x10 in.; pp. 132. 25c.

With the cooperation of consuls in the various countries named, the Bureau of Standards was able to collect and here present specifications for rails, wheels, axles and tires for the United Kingdom, Italy, France, Belgium, Germany, Austria, Holland and Sweden. The specifications are preceded by a brief discussion of each class. A few accident statistics are given. These include derailments on account of rails, wheels, axles and miscellaneous, together with persons injured, miles of track and other figures.

It is now becoming the fashion, and the fashion is a good one, for important departments of the various states to publish some kind of bulletin or journal, usually at monthly intervals. One of the latest publications of the sort is the "Minnesota Highway Journal," issued by the State Highway Commission, St. Paul, Minn. The first number (May) starts off very modestly with four 9x12-in. pages. It contains an account of road work in Minnesota in 1915, some figures and comments on the advance in steel prices, as affecting steel bridges with concrete floors and reinforced-concrete bridges, and facts about Minnesota bridge lettings and the duty of state highway commissions to supply bridge plans for use in connection with state-aid work. The two inside pages of the "Journal" are devoted to a tabulated statement

1916 bridge work by counties. This promises to be an interesting and valuable feature of the "Journal," as it appears to be the intention to publish the statement at intervals, if not indeed every month.

A map of the State of New York, showing the improved highways and many points of historical interest, was issued by the New York State Commission of Highways on May 1, 1916. No less than 122 different points of historical interest in various parts of the state are marked by numbers, and on the back of the map is printed a brief statement concerning the important events in history which occurred at each place. The map is on a scale of 9 mi. to the inch. It shows 7,300 mi. of state and county highways, 6,000 of which are completed. It also shows, by different symbols, 4,000 mi. of road improved by towns and counties and about 6,500 mi. of unimproved roads.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

THE ACTIVATED-SLUDGE PROCESS IN TREATMENT OF TANNERY WASTES—By Harrison P. Eddy and Almon L. Fales, 14 Beacon St., Boston, Mass. [Reprinted from the "Journal of Industrial and Engineering Chemistry," Vol. 8, No. 7, p. 648, July, 1916.] Paper; 6x9 in.; pp. 7.

ANNUAL REPORT OF DIRECTOR OF THE CHOSEN RAILWAYS, 1914—Ryuzan, Chosen, China: Railway Bureau of Government-General of Chosen. Paper; 7x10 in.; pp. 91; illustrated.

ANNUAL REPORT OF THE ASSOCIATION OF ONTARIO LAND SURVEYORS, 1916—Toronto, Canada: L. V. Rorke, Secretary. Paper; 6x9 in.; pp. 385; illustrated. $1.

APPORTIONMENT OF RAILROAD EXPENSES AND PROPERTY VALUES ON BASIS OF USE—By A. M. Sakolski, Delaware & Hudson Co., Albany, N. Y. [Reprint from the "Journal of Accountancy," August, 1916.] Paper; 7x10 in.; pp. 13.

AUTOMOBILIST'S POCKET COMPANION AND EXPENSE RECORD: Includes Owner's Record, Fixed-Charges Memorandum, Weekly Expense Record for One Year, with Monthly and Yearly Summaries, etc. New York: Norman W. Henley Publishing Co. Leather; 5x8 in.; pp. 169. $1 postpaid.

BRICK ROADS—By Vernon M. Peirce, Chief of Construction, and Charles H. Moorefield, Senior Highway Engineer. Washington, D. C.: United States Department of Agriculture. Bulletin No. 373. Paper; 6x9 in.; pp. 40; illustrated. 15c. a copy, from Superintendent of Documents, Government Printing Office, Washington, D. C.

CHEMICAL AND BIOLOGICAL SURVEY OF THE WATERS OF ILLINOIS: Report for Year Ended Dec. 31, 1914, of the Illinois State Water Survey—Urbana, Ill.: University of Illinois. Bulletin, Water Survey Series No. 12. Paper; 6x9 in.; pp. 261; illustrated. $1.

CONCISE TECHNICAL PHYSICS—By J. Loring Arnold, Ph.D., Professor of Electrical Engineering at New York University. New York: McGraw-Hill Book Co. Cloth; 5x8 in.; pp. viii + 275; 294 illustrations. $2 net.

THE CONSTRUCTION OF ROADS AND PAVEMENTS—By T. R. Agg, C. E., Professor of Highway Engineering, Iowa State College. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. vii + 432; 116 illustrations. $3 net.

ECONOMIC GEOLOGY—By Heinrich Ries, A. M., Ph.D., Professor of Geology at Cornell University. Fourth edition, thoroughly revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xviii + 856; 291 illustrations; 75 plates. $4 net.

ELECTRICAL CONSTRUCTION: An Elementary Course for Vocational Schools—By Walter B. Weber, Instructor in the Seneca Vocational School, Buffalo. Peoria, Ill.: The Manual Arts Press. Cloth; 7x10 in.; pp. 130; illustrated. $1.25.

ELECTRICAL TABLES AND ENGINEERING DATA: A Book of Useful Tables and Practical Hints for Electricians, Foremen, Salesmen, Solicitors, Estimators, Contractors, Architects and Engineers—By Henry C. Horstmann and Victor H. Tousley, authors of "Modern Wiring Diagrams," "Modern Electrical Construction," etc. Chicago: Frederick J. Drake & Co. Cloth; 4x7 in.; pp. 331; 34 illustrations. $1 net.

ELECTRIC MOTORS, DIRECT AND ALTERNATING: PRINCIPLES, CONSTRUCTION, OPERATION AND MAINTENANCE: A Practical Book for the Practical Man—By David Penn Moreton, B. S., E. E., Associate Professor of Electrical Engineering, Armour Institute of Technology. Chicago: Frederick J. Drake & Co. Cloth; 4x7 in.; pp. 328; 115 illustrations. $1 net.

ELEMENTS OF CHART MAKING—By E. Lester Jones, Superintendent. Washington, D. C.: United States Coast and Geodetic Survey. Special Publication No. 38. Cloth; 6x9 in.; pp. 15; 30 plates.

ELEMENTS OF MINING—By George J. Young, M. Am. Inst. M. E. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 628; 271 illustrations. $5 net.

FINANCIAL STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000 (1915)—Washington, D. C.: United States Bureau of the Census. Cloth; 9x12 in.; pp. 338.

THE MECHANICAL HANDLING AND STORING OF MATERIAL: Being a Treatise on the Handling and Storing of Material Such as Grain, Coal, Ore, Timber, Etc., by Automatic or Semi-Automatic Machinery, Together with the Various Accessories Used in the Manipulation of Such Plant—By George Frederick Zimmer, Assoc. M. Inst. C. E. New York: D. Van Nostrand Co. Cloth; 7x10 in.; pp. xiv + 752; 1,044 illustrations. $12.50 net.

METHODS OF SAMPLING DELIVERED COAL AND SPECIFICATIONS FOR THE PURCHASE OF COAL FOR THE GOVERNMENT—By George S. Pope. Washington, D. C.: United States Bureau of Mines. Bulletin No. 116. Paper; 6x9 in.; pp. 64; illustrated. 15c. a copy, from the Superintendent of Documents, Government Printing Office, Washington, D. C.

MINING DEVELOPMENTS AND WATER-POWER INVESTIGATIONS IN SOUTHEASTERN ALASKA—Papers by Theodore Chapin and George H. Canfield. Washington, D. C.: United States Geological Survey. Bulletin No. 642-B. Paper; 6x10 in.; pp. 127; illustrated.

MORTALITY LAWS AND STATISTICS—By Robert Henderson, Actuary of the Equitable Life Assurance Society of the United States. New York: John Wiley & Sons. [Mathematical Monograph No. 15.] Cloth; 6x9 in.; pp. v + 111; illustrated. $1.25 net.

NAVAL ARCHITECT'S AND SHIPBUILDER'S POCKET-BOOK of Formulae, Rules and Tables and Marine Engineer's and Surveyor's Handy Book of Reference—By Clement Mackrow, late Member of the Institution of Naval Architects; late Lecturer on Naval Architecture at the Bow and Bromley Institute, and Lloyd Woollard, Royal Corps of Naval Constructors; Member of the Institution of Naval Architects; Instructor in Naval Architecture at the R. N. College, Greenwich. New York: Norman W. Henley Publishing Co. Eleventh edition, thoroughly revised with a section on aeronautics. Leather; 4x7 in.; pp. xii + 742; 264 illustrations. $5.

OZONE: Its Manufacture, Properties and Uses—By A. Vosmaer, Ph.D., M. Am. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xii + 197; 67 illustrations. $2.50 net.

THE PHYSICO-CHEMICAL PROPERTIES OF STEEL—By C. A. Edwards, D.Sc., Professor of Metallurgy, Manchester University. Cloth; 6x9 in.; pp. x + 229; 181 illustrations. $3.50 net.

PRACTICAL SAFETY METHODS AND DEVICES: Manufacturing and Engineering—By George Alvin Cowee, E. M., S. B., Manager, Bureau of Safety, Utica Mutual Compensation Insurance Corporation. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. ix + 434; 128 illustrations. $3 net.

PRINCIPLES OF THE TELEPHONE: Part I. Subscriber's Apparatus—Prepared in the Extension Division of the University of Wisconsin by Cyril M. Jansky, B.S., B.A., Associate Professor of Electrical Engineering, and Daniel C. Faber, E. E., Assistant Professor of Electrical Engineering, University of Wisconsin. New York: McGraw-Hill Book Co. [Industrial Education Series.] Cloth; 6x9 in.; pp. xiii + 160; 125 illustrations. $1.50 net.

THE RAILWAY LIBRARY, 1915: A Collection of Addresses and Papers on Railway Subjects, Mostly Delivered or Published During the Year Named. Also Statistics for 1915—Compiled and edited by Slason Thompson, Director of Bureau of Railway News and Statistics, 1529 Railway Exchange Building, Chicago, Ill. Cloth; 6x9 in.; pp. 466; illustrated. $1.

REVENUE AND OPERATING EXPENSE OF MUNICIPALLY OWNED WATER-WORKS IN MASSACHUSETTS FOR THE YEAR 1913—By Charles W. Sherman, 14 Beacon St., Boston, Mass. [Reprinted from "Journal" of the New England Water-Works Association, Vol. XXX, No. 2.] Paper; 6x9 in.; pp. 260-266.

STANDARD METHODS OF GAS TESTING—Washington, D. C.: United States Bureau of Standards. Circular No. 48. Paper; 7x10 in.; pp. 202; illustrated. 40c. a copy, from the Superintendent of Documents, Government Printing Office, Washington, D. C.

STEAM POWER—By C. F. Hirshfield, M. M. E., Professor of Power Engineering, and T. C. Ulbricht, M. E., M. M. E., Assoc. M. Am. Soc. M. E., formerly Instructor, Department of Power Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. [Wiley Technical Series.] Cloth; 5x8 in.; pp. viii + 420; 232 illustrations. $2 net.

THE UNDERGROUND AND SURFACE WATER SUPPLIES OF WISCONSIN—By Samuel Weidman, Wisconsin Geological and Natural History Survey, and Alfred R. Schultz, United States Geological Survey. Madison, Wis.: Wisconsin Geological and Natural History Survey. Bulletin No. XXXV. Cloth; 7x10 in.; pp. 664; illustrated.

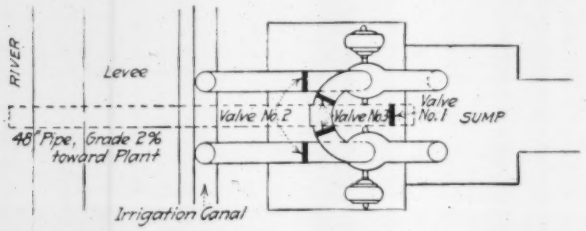
After a discussion of the water supplies of the state in general and by sources, including geological and chemical features, local water-supplies are described by counties, under these heads: (1) Geological formation; (2) supplies for cities and villages; (3) quality and analyses.

Field and Office

Pump for drainage and irrigation—Plank foundations unsuitable for permanent structures—Brick and tile sewers both fail under equivalent of 40 ft. of earth—Cinders packed around sheetpile joints stopped all leaking—Special roller for track paving—Standard Howe truss of Utah highway bridges—Pulling wagons from a cellar excavation in New York

Pumping Station Used for Both Drainage and Irrigation*

The Pritchard Lake pumping plant on the Sacramento reclamation district of the Natomis Co., in California, is used for both land drainage and irrigation. In this station there are two 36-in. centrifugal pumps, each driven through a flexible coupling by a 300-hp. 230-r.p.m.



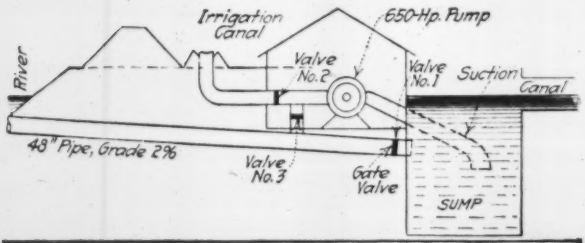


FIG. 1. PUMPING LAYOUT. FIG. 2. THE STATION

induction motor. The pumps operate against heads of 8 to 28 ft., the ordinary condition being against 18 ft. Minimum investment has been secured throughout. The pump motors are controlled from a main switchboard in the station gallery, being started directly from the main transformer bank, which delivers 1,100 volts for starting and 2,200 for running. Interlocked single-throw oil switches make the connections. The line is 54,000 volts.

*From information furnished by the Westinghouse Electric and Manufacturing Co., Pittsburgh, Penn., maker of electrical equipment in the Pritchard station.

The scheme of using the pumps for both irrigation and reclamation is shown in Fig. 2. The pumps are placed below water level and draw from a sump excavated to 10 ft. below the canal level and 8 ft. below river low water. A 42-in. pipe was laid on a 2% grade from the river to the sump. The pump discharges were connected through valves to this pipe and motor-operated valves were placed on each discharge line going to the irrigation ditch. There is a fifth valve (hand-operated, since it is opened only a few times a year) on the lower end of the 42-in. river line. By closing valves 1 and 2 and opening valve 3 (Fig. 1), water can be pumped from the sump into the river. By closing valve 3 and opening 1 and 2, river water can be elevated to the irrigation ditch.

Saving Canal Walls Built on Old Plank Foundations

By Walter H. Sawyer*

In some of the older hydraulic construction where fine sand or quicksand was encountered it was common practice to build permanent structures on wood-plank platforms surrounded, in some cases, by wood sheetpiling (see

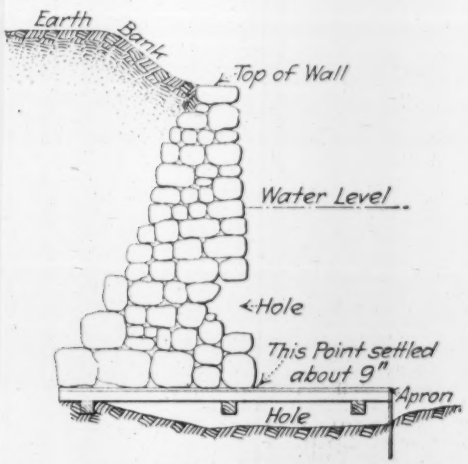


FIG. 1. CROSS-SECTION OF BREAK IN CANAL WALL, LEWISTON, MAINE

Fig. 1). Many of the canal walls of the Union Water Power Co. at Lewiston, Maine, are built on such platform foundations. After 60 years' use the platforms have become water-worn, although the timber is still sound. With the wearing of the platforms and the wooden treenails used to fasten them, the planks are frequently loosened so that water gains access to the filling under the platform, sometimes allowing the wall to settle.

A recent instance is a place immediately below the gatehouse of the Union Water Power Co. at Lewiston,

*Consulting Engineer, Lewiston, Maine.

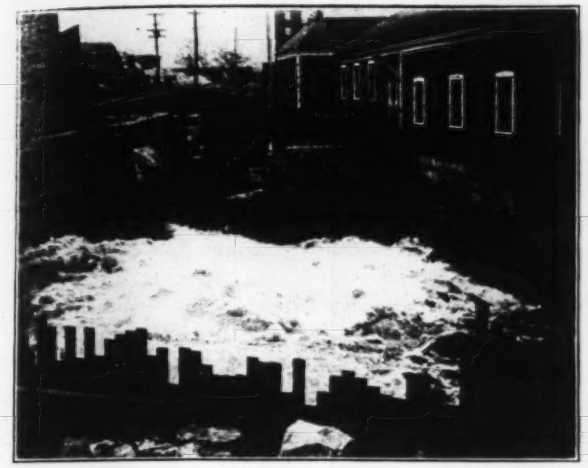


FIG. 2. CANAL IN FRONT OF COFFER-DAM, SHOWING DIFFICULTIES ENCOUNTERED FROM CURRENT

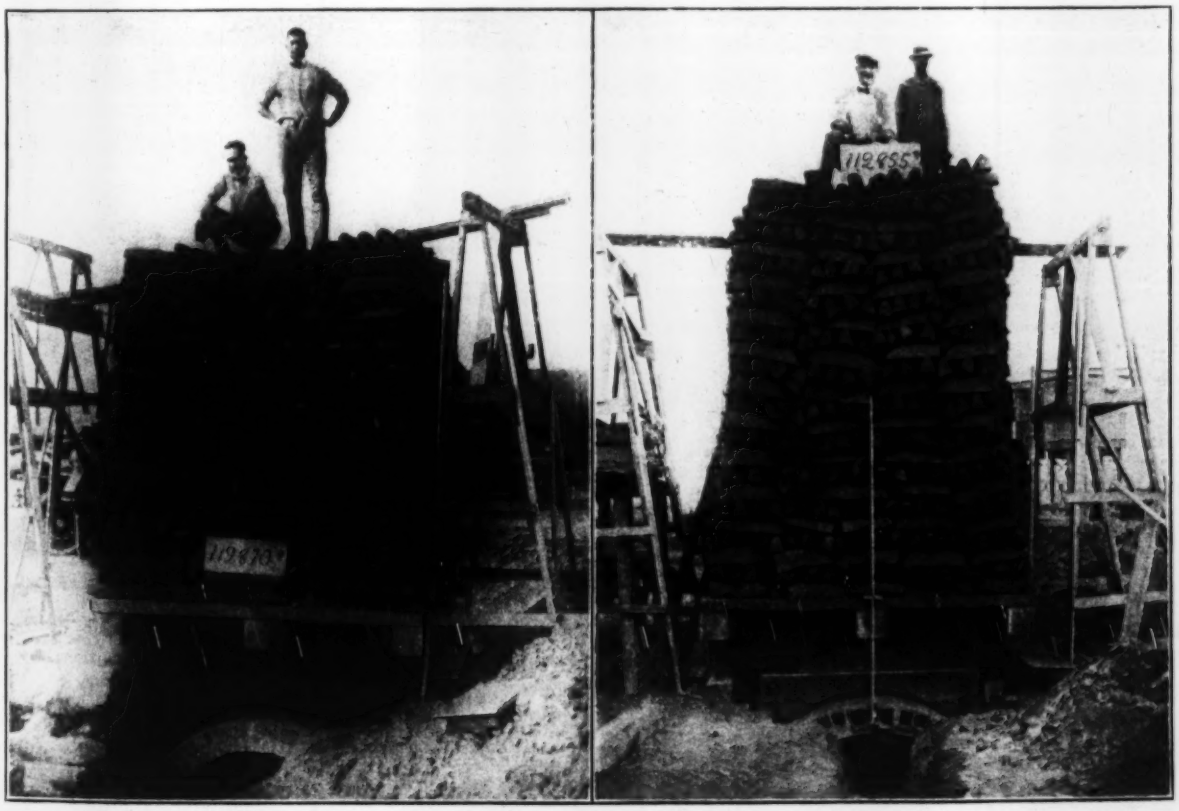
where a section of wall about 20 ft. in height was placed on a plank platform over a sand pocket. The platform projected into the canal about 10 ft. as a protecting apron. The constant rush of water over the apron has worn the planks so that during the last winter many of them were washed away, the filling under the apron was washed out and a portion of the wall settled and cracked. The place was a particularly difficult one to repair, as work must be done at night and on Sundays when the canal could be emptied.

Owing to the rapidity of the current, which would have washed away the concrete before it could set, a breakwater of heavy cribwork was built in the canal surrounding the break. The holes in the wall left by the falling stones were filled with concrete placed behind forms. The plank apron was covered with a concrete apron about 1 ft. in thickness, the apron being reinforced with old steel rods. Some sections of 2-in. pipe were inserted in various places in the wooden apron and concreted in. The voids under the apron were then filled with cement grout placed under a pressure of about a 20-ft. head.

Brick and Tile Sewers Cracked Under Same Loading

As a result of some discussion in St. Louis of the relative merits of brick and segment sewer blocks for street construction, comparative tests were made recently on 60-in. sewers of each type. The brick sewer was built in two rings and was an exceedingly good piece of work. The tile sewer is of "Ferguson Block" (manufactured in St. Louis). Sections 7 ft. long were built underground, and an area in the center 4 ft. long by 3 ft. 4 in. wide was loaded. The load was applied through a sand bed wrapped in canvas and inclosed in a heavy bolted timber saddle, the timber not touching the sewer. The 4x4-in. timbers shown in end view rested loosely on the sand and supported the cantilever platform. The soil in which the sewers were built is a very stiff yellow clay.

Both constructions showed the first crack at approximately 53,000 lb. The loading was continued to about 113,000 lb., at which time several cracks had opened up in the brickwork, and the tile was seriously cracked. At this load the deflection in the brick sewer at the crown was ½ in., and in the tile sewer about ⅞ in. The tile



BRICK SEWER AND TILE SEWER LOADED TO CRACKING

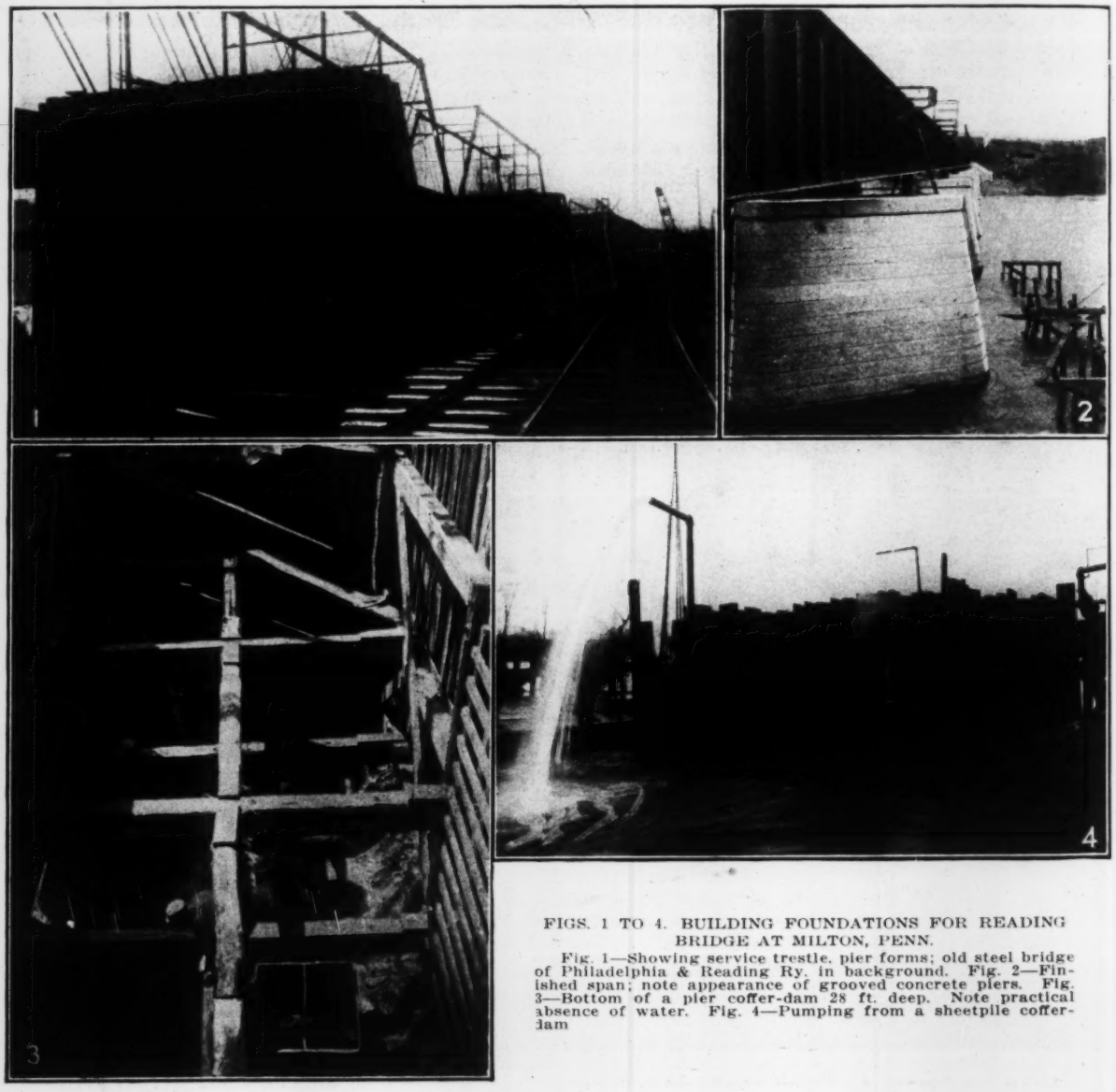
sewer continued to hold this load for 1½ days, after which it collapsed. The brick sewer showed no further deflection and was unloaded after about 10 days. It is interesting to note that the load at which each sewer cracked is equivalent to about 40 ft. of earth weight on the central portion of the arch, without relieving weight on the quarters or haunches, and indicates that both constructions are strong enough for all ordinary cases.

The only other conclusion to be drawn is that the two-ring brickwork in this size is somewhat stronger than the 7¼-in. thickness of the two-ring segment blocks.

Cinders Make Steel Sheeting Tight in Swift Current

Eliminating grades on the Philadelphia & Reading Ry., in the town of Milton, Penn., necessitated the building of two new girder bridges on that railway across the Susquehanna River, alongside the existing truss bridge. The two new bridges are in reality but one crossing, being connected by an earth fill on an island in the middle of the river. The foundation of each bridge consists of two concrete abutments and seven concrete piers. The connecting embankment contains 70,000 yd. of earth. The concrete in the foundations of the two bridges aggregates 12,000 yd.

The river at Milton averaged about 14 ft. in depth during the major portion of the pier work. The velocity was as high as 10 or 12 mi. per hr. At the pier sites steel sheetpile coffer-dams were put down, each about 20x40 ft. in plan, containing 104 sheetpiles, about 30 ft. long and 8 ft. above water. This meant that there were 104 joints in each coffer-dam, and each joint was 22 ft. long. The result was that leakage was excessive. This was obviated, however, when F. P. Kemon, the contractor's superintendent, put down outside of each steel joint a V-shaped wood trough consisting of two boards nailed edge to edge, and filled the space between wood and steel with cinders. These cinders were obtained at



FIGS. 1 TO 4. BUILDING FOUNDATIONS FOR READING BRIDGE AT MILTON, PENN.

Fig. 1—Showing service trestle, pier forms; old steel bridge of Philadelphia & Reading Ry. in background. Fig. 2—Finished span; note appearance of grooved concrete piers. Fig. 3—Bottom of a pier coffer-dam 28 ft. deep. Note practical absence of water. Fig. 4—Pumping from a sheetpile coffer-dam

a near-by electric-light plant and were transported to the bridge in ordinary cement bags, which were dumped into the V troughs. Mr. Kemon states that the leakage stopped under this treatment almost as if the water had been shut off by valves.

The concrete piers have been marked into courses, as shown in Fig. 2, and the piers are faced with a granolithic mixture. This mixture is disposed as follows: Steel forms are placed 1 in. inside the pier forms and are raised as the concreting proceeds, the granolithic mixture being put between the steel forms and the sheet-steel-lined wood forms of the piers.

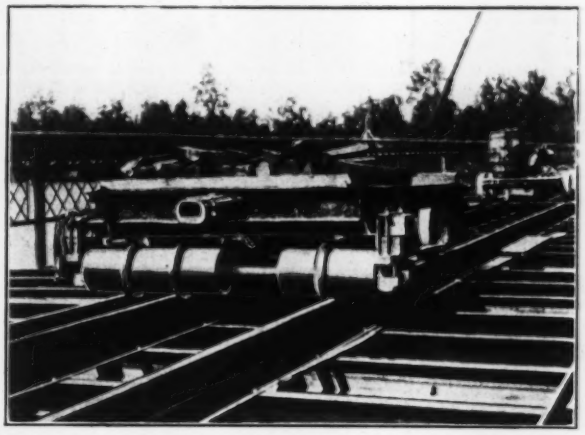
The work was carried on from a timber service trestle erected alongside the site of the new bridge. At Milton about 10 ft. of sand overlies the rock, so that the trestle posts could be driven. The trestle was therefore a stancher structure than the one being used at Harrisburg to erect the Susquehanna bridge of the Cumberland Valley R.R.

The foundations were placed by the Robert Grace Contracting Co., of Pittsburgh; F. P. Kemon, superintendent on the job. The Pennsylvania Steel Co. is finishing the erection of the girder spans, while at the present time the Reading Construction Co. is dismantling the old steel bridge for the Philadelphia & Reading Ry.

E. F. Gorman is Resident Engineer, C. Dillenbeck, Engineer of Bridges and Buildings, Samuel T. Wagner, Chief Engineer.

Roller Shapes Bridge Paving Alongside Car Track

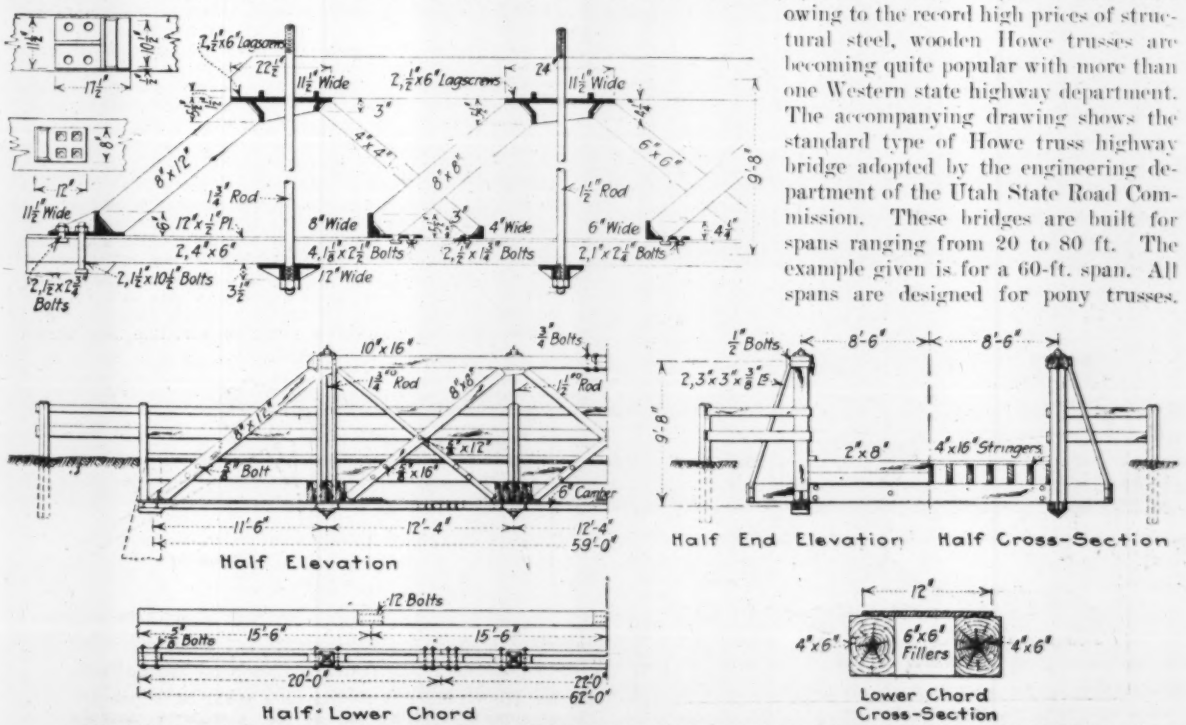
The Interstate Bridge, across the Columbia River near Portland, Ore., is paved with asphaltic concrete laid on a concrete slab floor. The header adjacent to the car tracks, which are for both wide and narrow gage, is of concrete, formed monolithic with the floor slab. The contractor, the Pacific Bridge Co., developed the rather novel roller shown in the accompanying view for forming the flangeways in these concrete headers. An axle, carrying turned cast-iron rollers of proper form was supported by bearings bolted on one end of a small steel car. By using a moderately wet concrete and passing this car over the surface several times, a very smooth and uniform flangeway was secured.



ROLLER ON CAR FORMS CONCRETE PAVING ON BRIDGE

Howe Truss Highway Bridge with Composite Chord

The day of the timber truss for highway bridges is by no means past. There are many sections of the country, particularly in the Northwest, where timber trusses will be used for many years to come. Right at this time, owing to the record high prices of structural steel, wooden Howe trusses are becoming quite popular with more than one Western state highway department. The accompanying drawing shows the standard type of Howe truss highway bridge adopted by the engineering department of the Utah State Road Commission. These bridges are built for spans ranging from 20 to 80 ft. The example given is for a 60-ft. span. All spans are designed for pony trusses.



STANDARD PONY HOWE TRUSS HIGHWAY BRIDGE, WITH COMPOSITE LOWER CHORD, UTAH STATE HIGHWAY DEPARTMENT

The bridge illustrated has a clear width of nearly 16 ft. It is designed for a dead-load of 680 lb. per lin.ft., a uniform live-load of 100 lb. per sq.ft., and a concentrated live-load of an 18-ton roller. The impact allowance for the trusses is 18% of the maximum live-load and for the floor system 25%. The 60-ft. trusses shown are given a camber of 6 in.

The essential feature of the bridge is the makeup of the lower chord, all the tension in which is carried by a steel plate laid on top of two 4x6-in. timbers, which give the necessary stiffness. The floor-beams and panel-point castings are laid on top of the lower chord plate.

The trusses are braced laterally at the panel-points by means of 3x3x3/8-in. angles extending from the upper chord to the ends of the floor-beams. In the 60-ft. truss shown braces are required at the end panel-points only.

A highway bridge of this type can be built for about half the cost of a steel truss or concrete-girder bridge designed for the same live-load. The standard steel bridges of similar spans have concrete floors, and possess correspondingly greater durability. The wooden bridge, however, requires less attention in certain localities, such as in the alkali country.

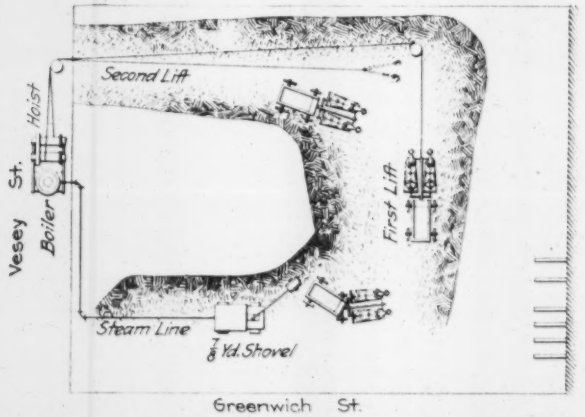
The bridge shown contains 14,107 board feet of lumber, 4,247 lb. iron in angles, plates, bolts and nails, 1,856 lb. castings and 729 lb. hangers and nuts.

The state road engineer of Utah is E. R. Morgan; the bridge engineer is Hugh C. Lewis.

Snatching Wagons in Two Lifts

Snatching wagons from a large cellar excavation for the Underwood Service Building, New York City, is done in two lifts, as shown in the sketch. Two lines are used running from a 2-drum Lidgerwood hoist. The longer line attaches to the hounds of a loaded wagon and pulls it rapidly to an intermediate elevation or landing where this line is unfastened, the wagon is given a half turn in the direction of the second incline, and the second line is fastened to the rear axle. The load is thus drawn to the street level. Connecting this line to the rear axle makes it possible to place the 2-sheave block well inside the curb line.

There are 12 to 18 trucks of 3-yd. capacity employed on this contract, each making 8 or 10 trips per day. They are loaded by a 7/8-yd. Bucyrus shovel working in the pit. Steam is supplied to it from the boiler of the hoist. The shovel will be used to a depth of 16 ft. below street level, from which point the excavation will be carried by hand work to a depth of 20 ft. The limiting factors in moving the material are the matter of available scows and the weather. The spoil has to be taken 3 m. out to sea, which restricts a scow to one load per day.

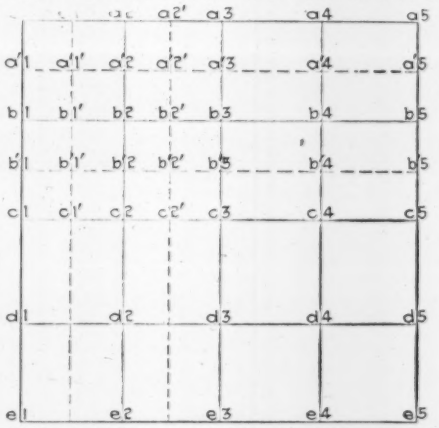


PULLING DUMP WAGONS FROM BUILDING EXCAVATION IN TWO LIFTS

The excavation on this 83x132-ft. plot is being done by F. H. Chapman. The architects for the building are McKenzie, Voorhees & Gmelin.

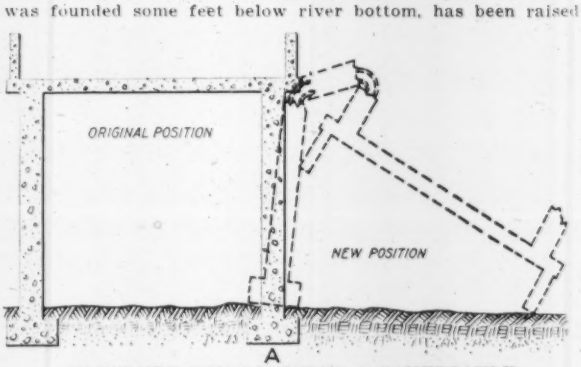
NOTES

Proposed Method of Designating Section Corners—In the "Michigan Engineers' Annual," 1894, appear four different systems of designating corners of sections and quarter sections. One of these was offered by F. Hodgman and is also found in his work on surveying. The discussion dwelt upon the fact that surveyors should adopt some easily remembered system of designating corners, so that a letter, figure or character might be jotted down and thus do away with the necessity of writing a more extended note, possibly under unfavorable conditions. I have a plan that I think is much better than any other I know of. It offers a designation for each corner of each 40-acre division of a section. This is of course particularly adapted to the regular subdivision of sections. I believe the more one studies the system and becomes familiar with its merits, the better it will be liked. It is very flexible and can be manipulated to indicate much by a brief note.—H. H. Rankin, C. E., Stronghurst, Ill.



PROPOSED METHOD OF DESIGNATING DIVISIONS OF PUBLIC LAND SURVEY SECTION

A Bridge Span Turned Upside Down by a flood is shown diagrammatically in the accompanying sketch. It is one span of the reinforced-concrete girder section of the Sloans Ferry bridge across the Catawba River in North Carolina, which was wrecked by the July floods, as described in "Engineering News," July 27, 1916, p. 185. S. H. Lea, City Engineer of Charlotte, N. C., who sent the sketch, says that this one span is overturned completely. The downstream post A, which was founded some feet below river bottom, has been raised



CONCRETE BRIDGE TURNS A SOMERSAULT

to the ground line; it served as a pivot on which the span somersaulted, breaking off one post completely and severing the other in two places. The pressure of the flood water, which was 4 ft. over the balustrade, was evidently tremendous.

Editorials

What Happened at Quebec

A steel rocker casting under one corner of the suspended span of the new Quebec Bridge first gave way. This is conclusively proved by the convincing array of structural evidence set forth in another part of this issue, obtained first hand by a member of the editorial staff of *Engineering News*, who made a careful examination of the entire lifting equipment left in place after the accident.

The results of this examination of the bridge are shown in this issue in a peculiarly graphic manner—with plan and perspective photographs accompanied by key sketches. This full record confirms the explanation of the accident given in *Engineering News* last week.

The statement of the condition of the lifting equipment and the explanation of the events of the disaster given in this issue have been verified by conference with the engineers of the St. Lawrence Bridge Co. and are harmonious with the official views.

Exactly how the accident happened can now be stated with certainty. To summarize concisely the more detailed statement made elsewhere: A steel casting by which the weight of the south upstream corner of the suspended span was transferred to the lifting girder broke in such a manner that the girder kicked back from under it. This corner of the span dropped into the water, starting transversal rotation of the whole south end of the span. For an instant there was heavy extra load on the downstream corner of the span, but the hanger held, and when the tipping progressed far enough the southeast corner also left its hanging support and went down into the water. Owing to the weakness of the laterals, the rotation of the south end of the truss was not very largely communicated to the north end, the trusses crumpling at the pin-connected joints. Both north corners therefore hung on until the other end of the span had disappeared under water and then let go, practically simultaneously.

So much for what actually happened. The question that arose at first in the minds of laymen and, indeed, in the minds of engineers not daily engaged in structural work was, "Why was not provision made against the effect of such a casting breaking?" The answer of structural designers, of course, is that there was no more reason to make such provision at the corner support that gave way than at each and every one of a hundred other parts of the bridge where treachery of material would have started an accident. There was no suspicion that here danger lurked unseen, and it was impossible to provide against the failure of material everywhere in the bridge.

In conclusion it is merely giving credit where credit is due to express our appreciation of the broad-minded, liberal attitude of the company and of the Board of Engineers in the face of this accident, and particularly of the president of the bridge company, Phelps Johnson. Every piece of information in the possession of the company has been made accessible. Every facility for examination has been provided. Every suggestion has been welcomed in the search for the cause. The whole procedure is a splendid example of high professional ethical standards in the administration of a gigantic construction enterprise at a time of great stress.

Watch Drifting-Sand Filters

It will be worth while to watch the results obtained from the large installation of drifting-sand water filters that will soon go into operation at Toronto, Ont. The major features of this new type of mechanical filters are filtration through (1) drifting sand and (2) a lower body of stationary sand, there being no physical separation between the two. The sand drift is provided by constant removal of a portion of the upper and moving sand body and the return of this sand through a vertical induction washer. The drifting action is depended on to render precoagulation unnecessary, while the constant washing of the drifting sand is expected to lessen materially the frequency of backwashing the entire sand body.

As is so common in both water and sewage treatment, the gains in the drifting-sand filters are to some degree offset by losses, or at least by added expense. Coagulation basins are cut out, and the effective filtering area is doubled, the engineers for the process state; but the sand bed is unusually deep. Frequency of complete washing is greatly reduced, but a part of the sand is being washed and returned every minute. The numerous units per filter tank add to the amount and complexity of both the structural work and the piping, as compared with the ordinary type of mechanical filter. All these things combined are not necessarily serious, but what the net gain of the new process will be is a matter to be determined by experience.

In passing, it may be noted that the early mechanical filters were operated without precoagulation; that one mechanical-filter company was wrecked by tackling a very turbid water without precoagulation; and that as experience with both mechanical and slow sand filtration has increased, coagulation basins have become more and more common and larger. All this, however, does not prove that drifting sand may not prove to be an efficient substitute for precoagulation, just as the activated-sludge process of sewage treatment may yet make preliminary sedimentation unnecessary.

The last remark suggests a likeness between the drifting-sand and the activated-sludge processes. In each case the liquid being treated is brought in contact with a moving medium. To go farther than has yet been attempted, or perhaps conceived before this, might the sand removing and renewing device in the drifting-sand filter be adopted for use in the removal of activated sludge and sewage and the return of a portion of the sludge to the activation tank? This question is rendered somewhat pertinent, perhaps, by the recently expressed opinion—in England and perhaps also in America—that mechanical agitation of sewage would serve as well as, if not better than, forced aëration.

The Toronto drifting-sand filters, described elsewhere in this issue, were made more costly and made also to cover more area than was necessary, because of a preference on the part of the city authorities for steel rather than reinforced-concrete tanks. The alternative bid for concrete was considerably lower than the accepted bid. At the same time, the accepted bid was deemed materially lower, according to Commissioner Harris' report (*Engineering News*, June 25, 1914) than the lowest competing bids for mechanical filters. To what extent this was due to a determination to install a large plant of the drifting-sand type in America we cannot say. One test of the new type of mechanical filters worth watching will be how it meets first-cost competition in the future. Another important factor to watch will be unit operation costs, and still another will be purification results.

Finally, the stress here laid upon watching the drifting-sand filters is not prompted by skepticism. These filters should be watched because, although brilliantly novel in the main principles of operation and in several details, they possess both the promise and the uncertainty of new processes or apparatus not yet tried on a large scale and under the varied conditions of many localities. It is a fine thing that Toronto had the courage to lead the way and afford the engineering profession a first-rate opportunity for watching drifting-sand filters.

Progress of the New England Water-Works Association

Milestone 35 was passed by the New England Water-Works Association when it closed its annual convention at Portland on Sept. 16. The 52 names added to the membership list during the convention equalled the total number of members at the time an ex-secretary of the association in attendance at Portland assumed office a quarter century or more ago. Thus far this year 150 new members have been enrolled. The aim is to make the gain for 1916 at least 200. This would bring the total up to 1,100. Since all water-works men everywhere are eligible to membership, it should be no hard task to get 50 more to join in the next three months.

The Portland convention accorded with the traditions of the Association in having business sessions and excursions sandwiched together so as not to give rise either to weariness or surfeit and to afford no lack of opportunity for social intercourse.

The number of papers and committee reports scheduled for most of the business sessions was perhaps too large, tending to haste and the curtailment of discussion. This might readily have been avoided, as some of the subjects hardly called for discussion, making presentation to the Association quite unnecessary. Of the half dozen papers and reports printed for circulation at the meeting, some might have been read by title only or in very brief abstract. It is a rare society and a rarer author that has sufficient restraint to refrain from reading at least the greater part of a paper, even if it is already in the hands of all the members.

The two sessions for superintendents narrowly escaped the pitfall that has invited disaster at conventions of the American Water-Works Association, namely, the monopolization of time by some controversial subject that does not greatly concern the superintendents, or else the use of overmuch time by engineers, material men or other special interests, so that the superintendents listen rather than discuss.

A weakness that besets all associations is the creation of numerous committees and the subsequent failure of the membership to give them support in the way of answers to questionnaires. This lack of coöperation was emphasized in the case of inquiries on pipe leakage recently sent out by a committee of the New England Water-Works Association. Only 20 or 25% of replies were received and many of these were scanty. It may be that some committees are given or themselves assume tasks that should not be attempted; or that inquiry blanks are not well framed; or that committees should not stop short with sending out one set of inquiries to the persons on their list. Still, more coöperation should be given or fewer committees should be created.

Notwithstanding the difficulties attending committee work, the Portland convention voted for the appointment of two new committees, each with much hard work to do if worthy results are accomplished. These were committees on accounting and on meter specifications. It is to be hoped that the members will support these committees in their arduous and important tasks.

It should be understood that none of the dangers here mentioned are peculiar to the New England Water-Works Association; that it has a good record for steering as clear of them as can be expected of any technical society; and, finally, that the Portland convention was pronounced by all in attendance to be one of the best water-works conventions ever held.

Indianapolis Fails To Protect Citizens from Typhoid

Some years ago, the 580 cases of typhoid fever at Indianapolis during the last three weeks in August would have been officially and popularly charged against the Indianapolis Water Co. Both general knowledge and local facts make that impossible now. Any city with a well purified water-supply, like that supplied by the Indianapolis Water Co., rests assured that it is protected against typhoid from water, if it will only use that and will shun less safe supplies.

A detailed investigation made years ago by an outside expert indicated that the excessive typhoid then prevalent at Indianapolis was due to thousands of unsewered premises and private wells. Some progress may have been made since then in bettering these dangerous conditions, but not enough. Four years ago an ordinance aimed at unprotected privies and the typhoid fly was defeated in the city council because of opposition on the grounds of expense and, we presume, interference with the freedom of the individual. Presumably, the people of Indianapolis have paid a yearly typhoid toll ever since and this year there is no question about it.

Of course there may be other causes than privies and polluted private wells for this typhoid outbreak at Indianapolis. Whatever the causes may be, it is the duty of the city to locate and eradicate them. The state and local health authorities appreciate this, but the city council seems to lack either the intelligence or the courage to do its part. The water company, however, if we understand local conditions, has the satisfaction of knowing that it has done its part toward eliminating typhoid from Indianapolis.

Post Bellum Influx Unlikely

There is a widespread belief in the United States that immediately after the close of the European War there will be an enormous influx of emigrants from Europe; and further that when the manufacturers of Europe turn from making munitions of war to making goods for sale, there will be a vast output of cheap goods dumped onto the American market. Concerning these predictions, it is of interest to note the following statement by the American Association of Commerce and Trade of Berlin printed in its bulletin for June:

> The American press is at present teeming with articles regarding immigration to the United States after the war. On this subject and that of dumping foreign goods, especially of German manufacture, on the American market after this terrible struggle is over there is wide misconception of the two states of affairs. There will be no emigration from Germany after the war for the reason that every able-bodied man will be able to find work at good wages. There will be no dumping after the war for the simple reason that there will be nothing to dump. German stocks are more or less depleted and those that are left will be required for home consumption, so the anti-dumping laws will be unnecessary.

Looking at the Inside of Reinforced Concrete

A most useful adjunct to the inspection of reinforced concrete has been developed in Switzerland, if the report of the United States consul at St. Gall in that country can be taken at its face value. According to Consul Ifft, an engineer of the Swiss Railway Department, one E. Stettler, has perfected a Roentgen ray apparatus whereby he is enabled to take photographs of a reinforced-concrete member so as to show, clearly enough for practical purposes, the disposition and size of the reinforcing steel embedded in the concrete.

Provided the cost can be brought within commercial limits, such photography has great possibilities, not only in the inspection, but in the test of concrete structures; for the misplacement of reinforcing steel is an old but recurring evil the effects of which are well known. Its discovery, however, is more than often difficult. Instrument manufacturers and testing engineers would do well to look further into the official report.

With the Sympathy of the Engineering Profession

Nine years ago, in the issue of *Engineering News* immediately following the collapse of the south cantilever of the Quebec Bridge, on Aug. 29, 1907, we said:

> It is with the keenest regret that we record the disaster to the great cantilever bridge under construction over the St. Lawrence River at Quebec. We are sure this regret is shared by every engineer who takes the least pride in his profession and its achievements. And the feeling is even deeper than regret. When the newspapers spread the news of the terrible disaster at Quebec to every corner of the country, thousands of engineers, as they read the story, were grieved and sick at heart. They felt not only horror at the loss of life, sorrow and sympathy for their brothers of the profession, but also a sense of personal loss as well.

There is no doubt that the engineering profession at the present day is, if possible, more deeply shocked and grieved than at the time of the catastrophe nine years ago.

The new Quebec Bridge represents the highest achievement ever recorded in structural engineering. The lessons taught by the unfortunate catastrophe of 1907 have been well learned. In the design, manufacture and erection of the new Quebec Bridge there has been nowhere any sparing of expense, any failure to employ the best technical skill, any lack of precautions to make certain that the finished structure should be as perfect as could possibly be built at the present day. That the failure of the material in one small detail, designed for use in the erection process and not in the finished structure, should destroy in a few seconds the great suspended span, the final link to complete the greatest bridge in the world, is a piece of most undeserved bad luck.

It is always easy to criticize after the event. Hindsight is always wiser than foresight. Who in the engineering profession has the cocksureness to say that he would have been wise enough beforehand to have imagined the possibility of this spectacular failure occurring in the way it actually did occur?

The men in charge of this most remarkable feat of bridge erection ever undertaken went to well-nigh unheard of lengths in computing and testing and determining beforehand the safety and certainty of each step of the process.

But experience teaches again that disaster may come, even to the most careful. In the light of what has happened at Quebec, engineers in every rank of the profession must realize anew that there is a lurking possibility of failure in every task that the engineer performs and that when such failures come those who suffer by it deserve the broad and generous sympathy of their brethren.

The final success of any great engineering work depends on a multitude of details and on eternal vigilance to see that none are neglected. It is the engineer's duty to study disasters to engineering works because of the useful lessons they may teach; but let him study them with all sympathy for his brother engineer who has borne the responsibility, remembering that he himself might have been in a like situation.

Explosions in Grain Separators

Any engineer who still has any doubt that fine dust floating in the air in proper proportions constitutes a powerful explosive and can be ignited without the presence of any inflammable gas will do well to study Bulletin 379 just issued by the Department of Agriculture. This bulletin reports the results of an investigation of the explosions and fires that have occurred in the grain separators of threshing machines in the Pacific Northwest. Its authors are David J. Price, of the Bureau of Chemistry, and E. B. McCormick, of the Office of Public Roads.

The investigation was made in eastern Washington, northern Idaho and northeastern Oregon. No less than 166 fires and explosions which occurred in grain separators while the wheat crop of 1915 was being threshed, were investigated. This section has an arid climate; and in the fall of the year when wheat threshing is going on, the air is usually very dry. The wheat crop of 1915 contained a large percentage of smut; and the investigations indicate that it was the very fine dust from this smut that exploded. The ignition of the dust-charged air appears to have occurred in most cases from a spark due to static electricity generated by some part of the machinery. The means suggested for preventing these explosions is grounding the separator to prevent the accumulation of static electricity and the attachment of a suction fan to the separator to remove the dust as it is formed.

Letters to the Editor

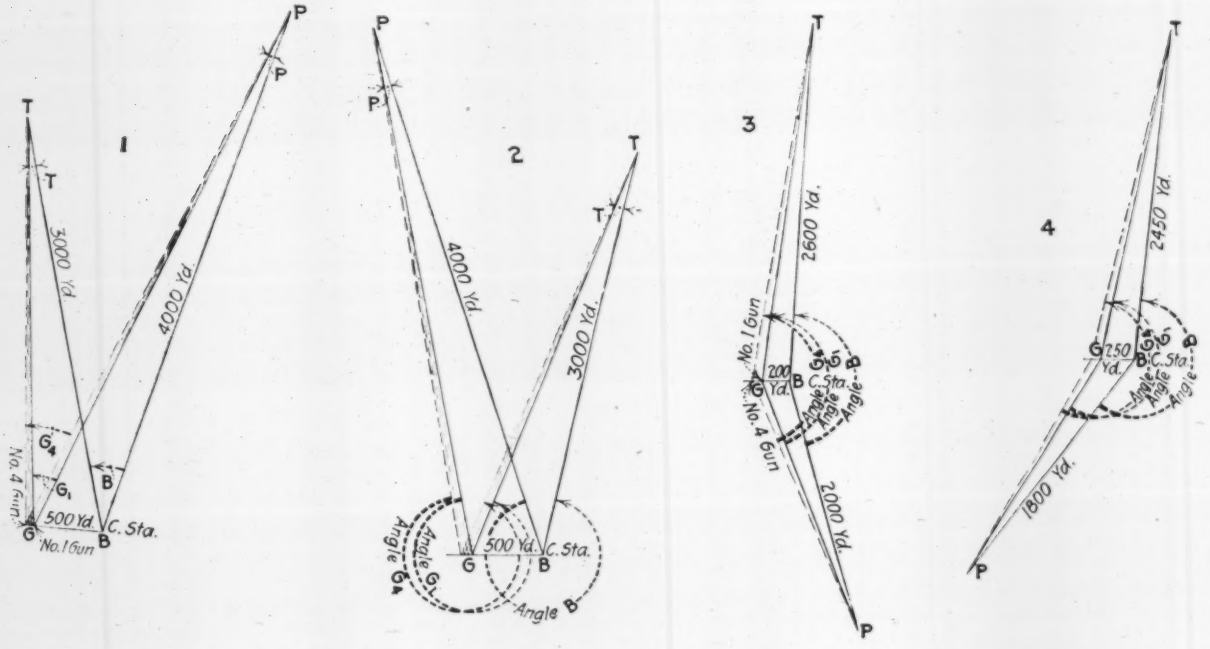
Field-Artillery Service for Civilian Engineers

Sir—I have read with interest the article entitled "Field-Artillery Service Should Attract Engineers," by Ernest McCullough, in *Engineering News*, Aug. 24, 1916.

In order to visualize the problem of gun pointing for indirect fire clearly, I have found it helpful to lay out on a celluloid triangle a small circle about 3 in. in diameter, divided into 64 equal parts, numbered counter-clockwise. With this protractor and a scale, any problem may be laid out with sufficient accuracy. The method of solution is interesting to the civilian engineer used to making calculations of this sort with a seven-place logarithm table.

The rule of plus and minus signs is perhaps the most difficult one for the beginner to grasp, and the best way to illustrate this law is to solve several problems.

In measuring angles the battery commander's telescope is used. This telescope is mounted on a tripod similar to an engineer's transit, but the telescope is vertical instead of horizontal and arranged exactly like the periscope on a submarine. The horizontal circle is divided into 64 equal divisions. The telescope has two



PROBLEM 1

Range, 3,000 yd.; target, left front; B C station, 500 yd., right flank. Aiming point, 4,000 yd., right front.

B = 520 — 520 mils

$P = \frac{500}{4} \times 1 = +125$

$T = \frac{500}{3} \times 1 = +170$

P — T = —45 —45 mils

G = B + (P — T) = 475 mils

Deflection Difference:

For converging fire

$P' = \frac{20}{4} \times 1 = +5$ mils

$T' = \frac{20}{3} \times 1 = +7$ mils

P′ — T′ = —2 mils

Therefore "close by 2."

For parallel fire

$P' = \frac{20}{4} = +5$ mils

T′ = 0 mils

P′ — T′ = +5 mils

Therefore "open by 5."

PROBLEM 2

Range, 3,000 yd.; target, right front; B C station, 500 yd., right flank. Aiming point, 4,000 yd., left front.

B = 5,870 — 5,870 mils

$P = \frac{500}{4} \times 0.9 = +120$

$T = \frac{500}{3} \times 1 = +167$

P — T = —47 —47 mils

G = B + (P — T) = 5,823 mils

Deflection Difference:

For converging fire

$P' = \frac{20}{4} \times 1 = +5$ mils

$T' = \frac{20}{3} \times 1 = +7$ mils

P′ — T′ = —2 mils

Therefore "close by 2."

For parallel fire

$P' = \frac{20}{4} = +5$ mils

T′ = 0 mils

P′ — T′ = +5 mils

Therefore "open by 5."

PROBLEM 3

Range, 2,600 yd.; target, right front; B C station, 200 yd., right flank. Aiming point, 2,000 yd., right rear.

B = 2,880 — 2,880 mils

$P = \frac{200}{2} \times 0.96 = -90$

$T = \frac{200}{2.6} \times 1 = +77$

P — T = —167 —167 mils

G = B + (P — T) = 2,713 mils

Deflection Difference:

For converging fire

$P' = \frac{20}{2.0} \times 0.9 = -9$ mils

$T' = \frac{20}{2.6} \times 1 = +8$ mils

P′ — T′ = —17 mils

Therefore "close by 17."

For parallel fire

P′ = —9 mils

T′ = 0 mils

P′ — T′ = —9 mils

Therefore "close by 9."

PROBLEM 4

Range, 2,450 yd.; target, right front; B C station, 250 yd., right flank. Aiming point, 1,800 yd., left rear.

B = 3,760 — 3,760 mils

$P = \frac{250}{1.8} \times 0.8 = -110$

$T = \frac{250}{2.45} \times 1 = +100$

P — T = —210 —210 mils

G = B + (P — T) = 3,550 mils

Deflection Difference:

For converging fire

$P' = -\frac{20}{2.4} \times 1 = -8$ mils

$T' = +\frac{20}{1.8} \times 0.8 = +9$ mils

P′ — T′ = —17 mils

Therefore "close by 17."

For parallel fire

P′ = —8 mils

T′ = 0 mils

P′ — T′ = —8 mils

Therefore "close by 8."

movements similar to the transit, and a micrometer permits the reading of horizontal angles to single mils—$\frac{1}{6400}$ of the circumference—and also vertical angles to 100 mils through a small arc. The graduations on the horizontal circle are numbered counter-clockwise. The upper plate is notched at the even 100-mil divisions, and a spring engaging the notches sets the instrument automatically at these divisions. The micrometer takes the place of the slow-motion screw of the transit.

This telescope, properly leveled, with the index set at zero, is first pointed at the aiming point, usually an easily defined object whose distance to the battery is approximately known. The lower motion is then clamped, the plates released, and the telescope is pointed at the target. The angle with the aiming point—angle B it is usually called—is read on the micrometer.

The distance from the battery commander's station, which is usually some multiple of a platoon front for convenience, is divided by the distance to the aiming point expressed in thousands of yards, and the quotient is multiplied by a percentage correction for the obliquity of the line BP with the line GB from No. 1 gun to the battery commander's station. The result is the angle P. The above correction is the sine of the angle which the line BP makes with the line GB. The sines of the angles 400, 800, 1,200, etc., to 6,400, are usually memorized. For an angle between 400 and 500 mils this correction is approximately 90%. For 800 mils it is 70%; for 1,200 mils, 40%; for 1,600 mils, zero, etc.

The angle T is found in the same way and is always given the positive sign. The angle P is positive or negative as the aiming point happens to be in the front of or in the rear of the battery. The angle G, or PGT, the deflection angle of No. 1 gun, is then equal to angle B plus $(P - T)$.

The deflection of No. 2 gun is found in exactly the same way, angle P' being equal to 20 yd. divided by the distance from the battery to the aiming point, and T' 20 yd. divided by the distance from the battery to the target, corrected as above, both divisors being, of course, expressed in thousands of yards. This deflection difference, $P' - T'$, is added algebraically to the deflection of No. 1 gun. For the deflection of No. 3 gun the difference is multiplied by 2, and for the deflection of No. 4 gun this is multiplied by 3.

The above difference is for converging fire. The process of finding the deflection difference for parallel fire is exactly the same as for converging fire, the angle T in this case becoming equal to zero.

TRESHAM D. GREGG.

Minneapolis, Minn., Aug. 30, 1916.

[It seems justifiable to publish the preceding letter, which in connection with Ernest McCullough's article brings before civilian engineer readers a development in reconnoissance surveying that might otherwise be lost sight of. It is easily conceivable that the mil-graduated circle and the quick methods of roughly estimating distances could be utilized to advantage in rough preliminary or reconnoissance surveys for a variety of purposes. The incipient surveyor-inventor looking for opportunities to introduce new methods may possibly see the germ of a valuable improvement in the decimal system above described. Moreover, a little careful study of the two articles will enlighten civilian engineers generally on a subject with which the majority are entirely unfamiliar.—Editor.]

No Residence Restrictions for Engineers

Sir—I was much interested in your editorial in *Engineering News* of Aug. 31 regarding the evil of local license laws for engineers. Your views reflect the enlightened thought of the time. The competent man fears no fair and honorable competition and needs no so-called protective legislation. The advocacy of license laws implies the conviction of incompetence in the consciences of the advocates thereof.

Some eighteen months ago I wrote a letter to the Secretary of the Western Society of Engineers opposing the bill then pending for licensing structural engineers in Illinois. I quote from that letter as follows:

This bill avowedly is intended to mitigate certain intolerable conditions growing out of the architects' license law and, like the latter, is a piece of class legislation. In my opinion there is only one proper way of accomplishing the object desired—namely, the repeal of the architect's license law.

All such laws, in the last analysis, are founded upon the principle of the closed shop, no matter how plausible may be the pretext for their necessity. They grow out of an economic misconception and will most surely have the same ultimate effect upon public welfare as sumptuary laws have had throughout all history.

In my opinion the advocacy of such laws by the engineering profession seriously detracts from professional dignity and, in fact, places the engineer in the public mind upon the same or a similar level with the plumber and similar classes, who have had class legislation enacted for their selfish interest. Such legislation must ultimately be borne by the public, and it is becoming an increasing public burden.

Experience has shown that examining boards are very sensitive to the exigencies of politics rather than the requirements or the intent of the law under which such boards operate, in such matters, and we all know how easy it is for an examining board to disqualify any candidate they may choose. We also know how humiliating it is for a man who has been practicing fifteen years or more to take examinations of this character, when he knows that the examining board have it in their power to stigmatize his reputation by disqualification, if they choose. Such examining boards at first are actuated only by altruistic motives, but sooner or later they succumb to the temptations of politics.

When the Federal Constitution was adopted, it was expressly provided that the Government should control the commerce between the states. The object was to prevent the establishment of tariff walls between the states. Recently the Supreme Court of the United States decided that the preferential railway rates established by the Texas Railroad Commission were repugnant to the Constitution because of an interference with interstate commerce. The writer therefore strongly feels that the adoption of such a law would ultimately be harmful—first, to the engineering profession and, second, to the public at large.

F. W. GREEN,

General Manager, Louisiana & Arkansas Ry.

Stamps, Ark., Sept. 4, 1916.

Vocational Guidance

Sir—The article on "Professional Misfits," by Prof. W. M. Wilson, in *Engineering News* of Aug. 31, 1916, is extremely interesting. When the writer attended the Massachusetts Institute of Technology in 1893, a system of vocational guidance was in operation there. It is necessary that a committee of three competent men should consult with and advise each student before he makes his final choice. The problem is distinctly one for the college authorities. Each instructor and professor should appoint himself a committee of one to improve his acquaintance with the students. LOUIS P. BUFF.

Jamaica Plain, Boston, Sept. 2, 1916.

Drifting-Sand Water Filters for Toronto, Ont.

SYNOPSIS—72,000,000-gal. (Imp.) maximum-capacity mechanical water-filtration plant of the Ransome drifting-sand type will soon be in operation at Toronto alongside the 48,000,000-gal. (Imp.) maximum-capacity slow sand filters completed in 1912. Major features are the constant removal, washing and replacing of a portion of the filtered sand by untreated water; filtration through drifting renewed sand above and nonmoving sand below, and the entire absence of a coagulating basin. Novel details are the alum-storing tank, alum-solution trough, constant-density alum-feed control, raw-water control and the large quick-discharging wash-water tank for backwashing the entire body of filter sand with filtered and disinfected water at weekly or 10-day intervals.

The rapid growth of Toronto having made necessary a large addition to its filtered-water supply from Lake Ontario, and the combination of occasional high turbidities and low winter temperatures having convinced the city authorities that the new filter should be of the mechanical

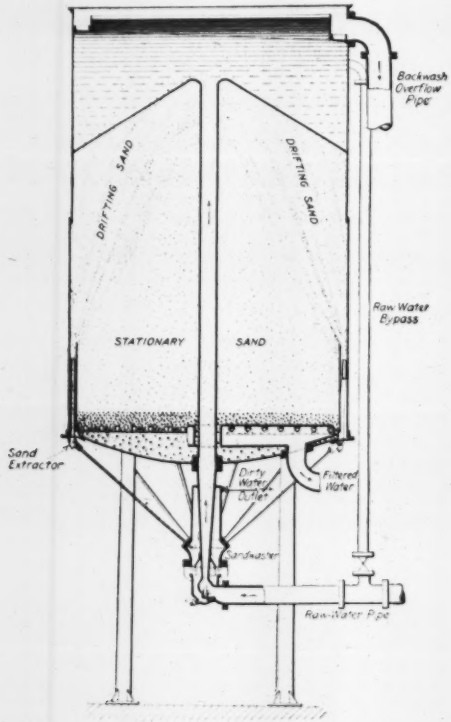


FIG. 1. TYPICAL UNIT OF DRIFTING-SAND FILTER
There are 30 of these units in each of the 10 filters of the Toronto plant

rather than the slow sand type, general specifications for mechanical filters were drawn and bids were received in January, 1914, by R. C. Harris, Commissioner of Works of Toronto. The accepted bids (June, 1914) were for Ransome drifting-sand filters. The plant was designed by the John verMehr Engineering Co., Ltd., of Toronto, Canada, and London, England, with William Gore as consulting and William Storrie as chief engineer (154 Simcoe St., Toronto). It is being constructed by the company named and William Cowlin & Son (Canada), Ltd., of Toronto, and Bristol, England. It will be by far the largest drifting-sand filter plant ever built

FIG. 2. GENERAL VIEW OF NEW FILTER PLANT

and the first one of considerable size in North America. The contract price for the plant was $1,066,282.[1]

The plant has a contract capacity of 60,000,000 gal. (Imp.) in 24 hr., but must be able to work at the rate of 72,000,000 gal. per day for a period of 10 hr. It is located on Toronto Island, close by the slow sand filters completed in 1912 (see *Engineering News*, Mar. 9, 1911, p. 302). The two plants combined will give a safe working capacity of 100,000,000 gal. (Imp.) a day. The present estimated population of Toronto is 500,000.

The following description is based on information obtained from Messrs. Gore and Storrie by a member of the editorial staff of *Engineering News* during a visit to the plant in the latter part of August, 1916.

Principle of Drifting-Sand Filter

Before describing the plant in detail, the design and operation of a typical working unit (Fig. 1) may be outlined. The object is to do away with precoagulation and to obviate the necessity for frequent shutdowns to wash the whole bed of filtering material.

The coagulant is introduced as the water goes to the filters. By causing the upper part of the sand bed to drift across the path of the raw influent water the bulk of the impurities are swept out, together with a part of the drifting sand—the latter being washed and returned by the constant circulation of the water and sand. The fixed lower portion of the sand bed takes out the remaining impurities. As often as local conditions demand, the whole bed is washed by a reverse flow of filtered and disinfected water.

The fine sand is 9 ft. deep, of rounded water-worn material. It has a maximum size of 1.2 mm., with 60% less than 0.7 and 10% less than 0.35 mm. Beneath the sand is a 9-in. layer of water-worn graded gravel, from 20 to 30 mm. in size. No screens are used between the gravel and the sand.

The coagulated raw water enters the filter partly by a standpipe at the center of the unit, passing up through a

[1]See "Engineering News," June 25, 1914, p. 1446, for an account of the contract letting, and Apr. 8, 1915, p. 680, for a description of the demonstrating plant at Toronto and related matters.

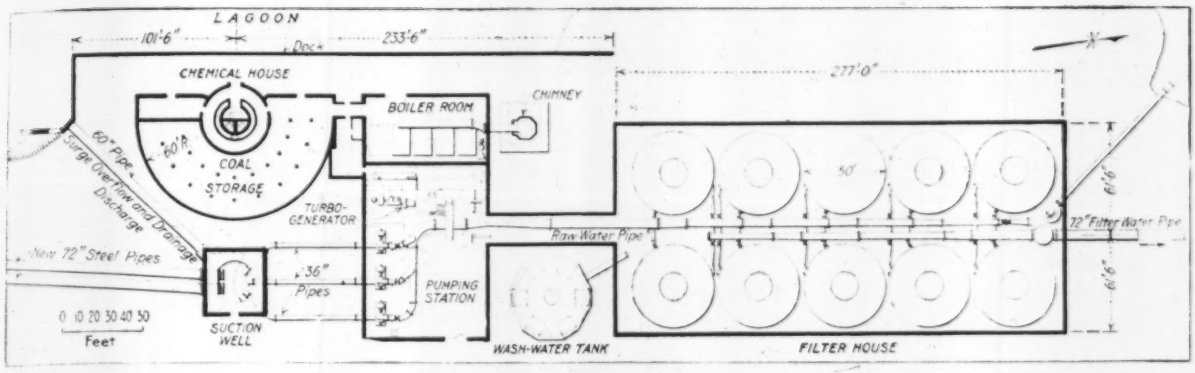


FIG. 3. LAYOUT OF TORONTO DRIFTING-SAND FILTRATION PLANT

separator or sand washer at the bottom, and delivers above the sand at the top and partly through a bypass. Within the sand washer the raw-water pipe is constricted like the tube of a venturi meter, and the drifting sand collected and washed in the separator is inducted into the raw water at the throat of the venturi tube. This sand passes up the standpipe with the water and is delivered with it above the top of the sand already there, forming a volcano-like cone that continuously drifts away and is continuously being replaced, leaving a round-topped body of stationary sand below, resting upon the filtered-water collecting system. The stationary sand does the final filtration. Its surface is more than twice the plan area of the unit and economizes the plan area of the filters. The drifting sand passes down all round the boundary of the stationary sand to a slot and ultimately through converging ports to a system of outlets or extractors and thence by pipes to a sand washer. Here the sand falls to the bottom through a current of raw water and is picked up by the inductor. The dirty water passes upward and out at the top by an outlet suitably controlled. The sand traps are of such a form that the sand is kept out of the piping system except when the inductor is in full operation. That is to say, the sand moves only when there is an abundance of running water to carry it forward.

The question of sand scour is an important one. The form of the inductor is such that the sand enters the high-velocity water at the center of the stream and can only touch the sides of the pipe after the sand and water have been reduced to nonscouring velocities. The loss of head at the inductor is about 3½ ft., but a bypass is provided so that the induction may be varied either at will or automatically in such a way as to suit the amount of the impurities and of the coagulants in the water, it being understood that the greater the proportion of the total raw water flowing through the inductor the greater will be the rate of the drifting sand.

So much for the principle of the drifting sand. We now deal with its application to the Toronto plant, a general view of which is shown by Fig. 2, while Fig. 3 shows the layout of the plant.

The two 72-in. intake pipes from Lake Ontario enter a suction well provided with a surge overflow and with duplicate screens having an area of 360 sq.ft. of ¼-in. mesh copper wire. The coagulant in the form of a solution of about 5% strength of aluminum sulphate is added to the water in the suction well by means of a perforated pipe (Fig. 4).

Chemical House and Coal-Storage Bin

The chemical house and coal-storage bin (Fig. 4) are of reinforced concrete with a partial brick façade and are arranged in one group of buildings 120x80 ft. in order that the facilities for unloading and loading materials from the wharf shall be common to both. Storage for 1,500 tons of coal and 800 tons of aluminum sulphate, as well as a general store, are provided for.

The arrangements for the supply of aluminum sulphate to the water before filtration are novel. The underlying

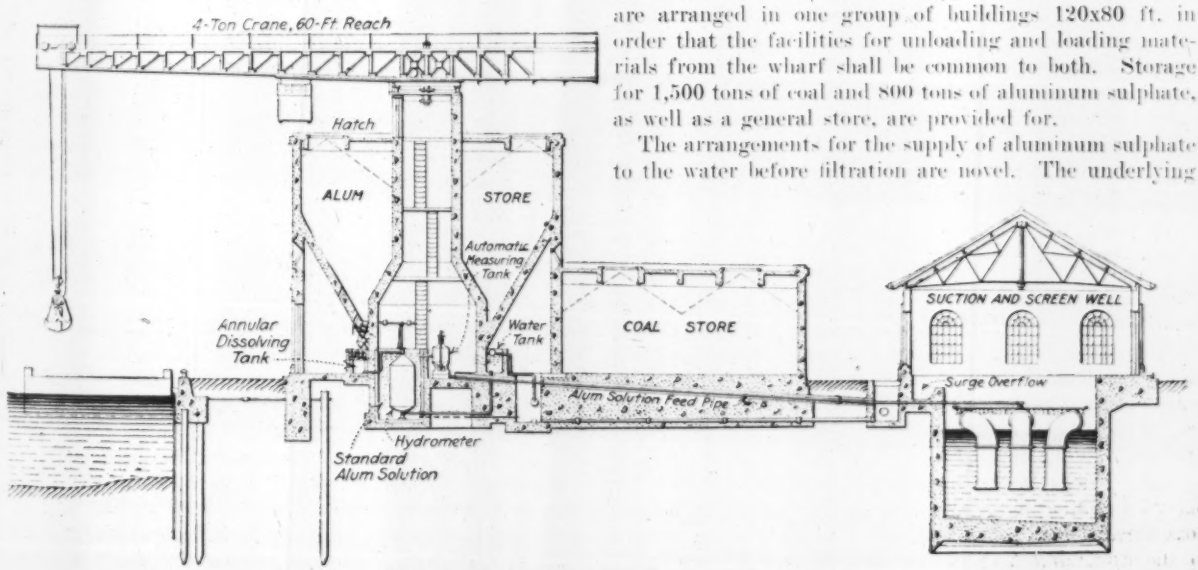


FIG. 4. CHEMICAL-SUPPLY DETAILS, TORONTO FILTERS

idea (Fig. 4) is to allow the dry chemical to feed down automatically from the storage bin through a number of control doors to a tray at midlevel in a dissolving channel maintained full of water. The solution formed may be of any strength in excess of 5%, and this solution is fed from the bottom of the dissolving channel into a dilution tank in which it is automatically diluted down to the standard 5% by a hydrometer-like arrangement. From this tank the standard solution is fed into a measuring tank controlled by the 72-in. venturi raw-water meter in the pumping station through a combined electric and hydraulic relay. From the bottom of the measuring tank the solution gravitates through lead pipes to the suction well and is there distributed over the water as previously described. The apparatus is in duplicate. In the section (Fig. 4) some of the parts have been displaced in order better to illustrate their working. The annular dissolving-channel tank is maintained full of filtered water by a float valve. From the water tank the water flows freely to the dissolving tank or channel and after dissolving the aluminum sulphate passes through a valve at the top of the hydrometer (hydrogravimetric balance). At the same time the water also comes from the water tank to a valve at the bottom of the hydrometer.

The hydrometer is poised in the solution between the two valves. Any vertical movement of the hydrometer opens one valve and closes the other. Thus it will let in strong solutions at the top and water at the bottom until the balance is obtained, when the hydrometer just floats in a solution containing 5% of aluminum sulphate. Any change from this strength causes the hydrometer to move and close one valve and open the other. It should be remembered that a 5% solution of aluminum sulphate is about 2½% heavier than water, and it is due to this fact that the apparatus works properly, not only from the point of view of supplying the energy to move the hydrometer, but also to mix the diluting water with the solution already in the chamber. The heavier liquid put in at the top tends to sink rapidly to the bottom, and on the other hand the lighter liquid fed in at the bottom tends to rise rapidly to the top; thus the liquid is maintained in a rapid state of circulation. A beam with knife-edges above the hydrometer provides for permanent adjustment and also for working with any desired density of solution. There is a scale with divisions for each 0.1 grain of coagulant per gallon of raw water, so that by simply moving a weight along a beam any desired amount of aluminum sulphate may be added to the water. The standard solution passes freely to the measuring tank and away to the suction well. For every rate of water passing through the raw-water meter there is a corresponding position for the hydraulic piston and gaging slot in the measuring tank. The filters are 10 in number, placed in two rows (Fig. 3), leaving a wide space between for the main pipes below and for the operating floor above. Each filter tank (Figs. 5, 6 and 7) is of steel, 14 ft. high and 50 ft. in diameter, divided into 30 units similar in every way to the unit shown by Fig. 1. These units are nested together in two rings of 18 and 12 respectively, leaving a space at the center 16⅔ ft. in diameter, in which is placed the raw-water control balance.

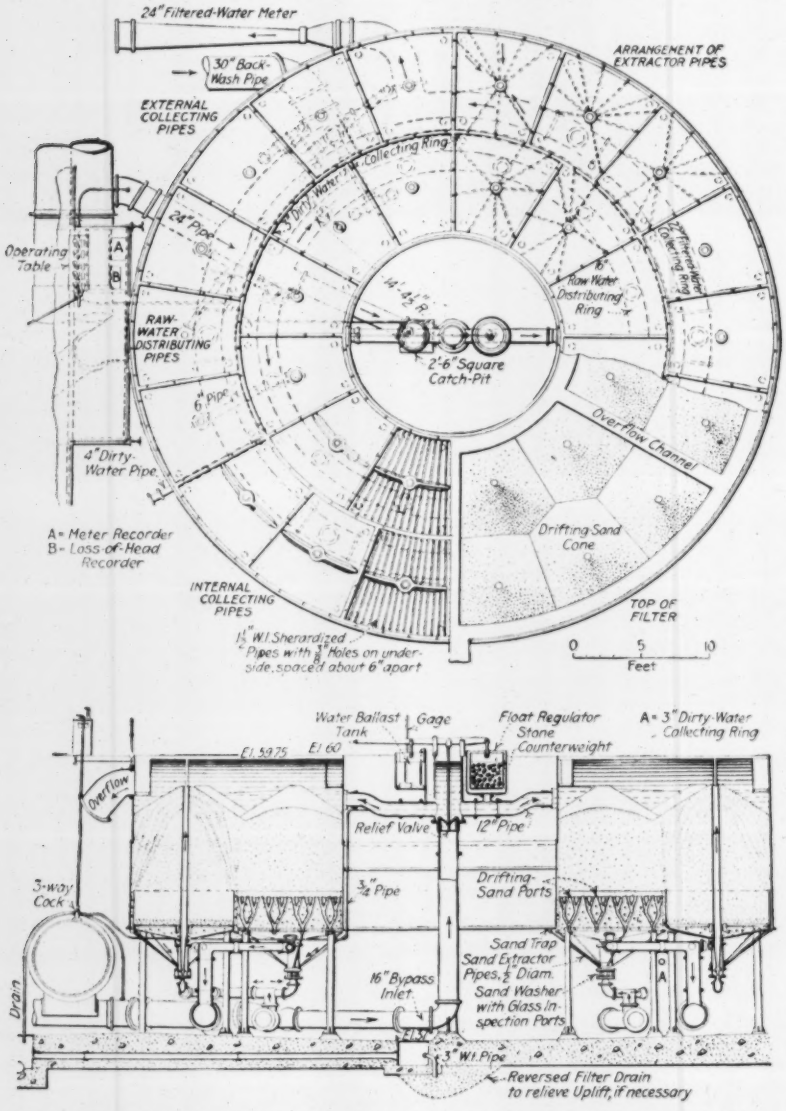


FIG. 5. DETAILS OF DRIFTING-SAND FILTER AT VARIOUS HORIZONTAL AND VERTICAL PLANES

The combined horizontal sand area of the 10 filters is 17,450 sq.ft., but the effective final filter area, or the area of the 30 conically or rounded tops of the stationary sand, is 35,000 sq.ft., or 0.8 acre. The stationary-sand cones have a slope of about 64° with the horizontal plane. The drifting-sand cones slope about 32°. The average total depth of sand in a filter is 9 ft.; minimum depth of stationary sand, 2 ft. 2 in.; and of drifting sand, 2 ft. 6 in. The total sand volume per filter is 600 cu.yd.

The loss of head in the sand washers is 3½ ft. and in the sand 10½ ft., or a total of 14 ft. The raw water that escapes from the sand washers as dirty washed water is 2% of the water filtered.

It is expected that the whole bed of sand will have to be backwashed once in 10 days. This will be done with filtered and disinfected water from a 200,000-gal. (Imp.) wash-water tank of steel 60 ft. above the ground surface and 45 ft. above the surface level of the filters. Half the contents of the tank will be discharged at a gradually increasing rate in 10 min. and half at the maximum rate in 5 min., the maximum vertical rise through the filter being 2 ft. per min. The wash water will pass through a measuring tank to lagoons, where the spent hydrate of alumina will be settled out.

The raw water enters each filter partly through the sand washers and partly through a bypass, controlled by a loaded valve. By means of this raw-water control balance, the rate of flow through the sand washers and thus the drift of the sand may be increased or decreased and the rate of direct admission of raw water be changed.

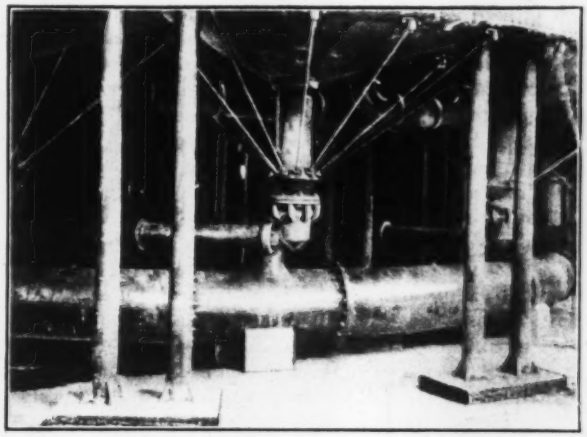


FIG. 7. SAND TRAPS, EXTRACTOR PIPES AND WASHERS

The small inclined pipes lead from the sand traps to the sand washer, which extends up through the bottom of the tank. There are 264 traps and sand pipes and 30 washers to each of the 10 filters

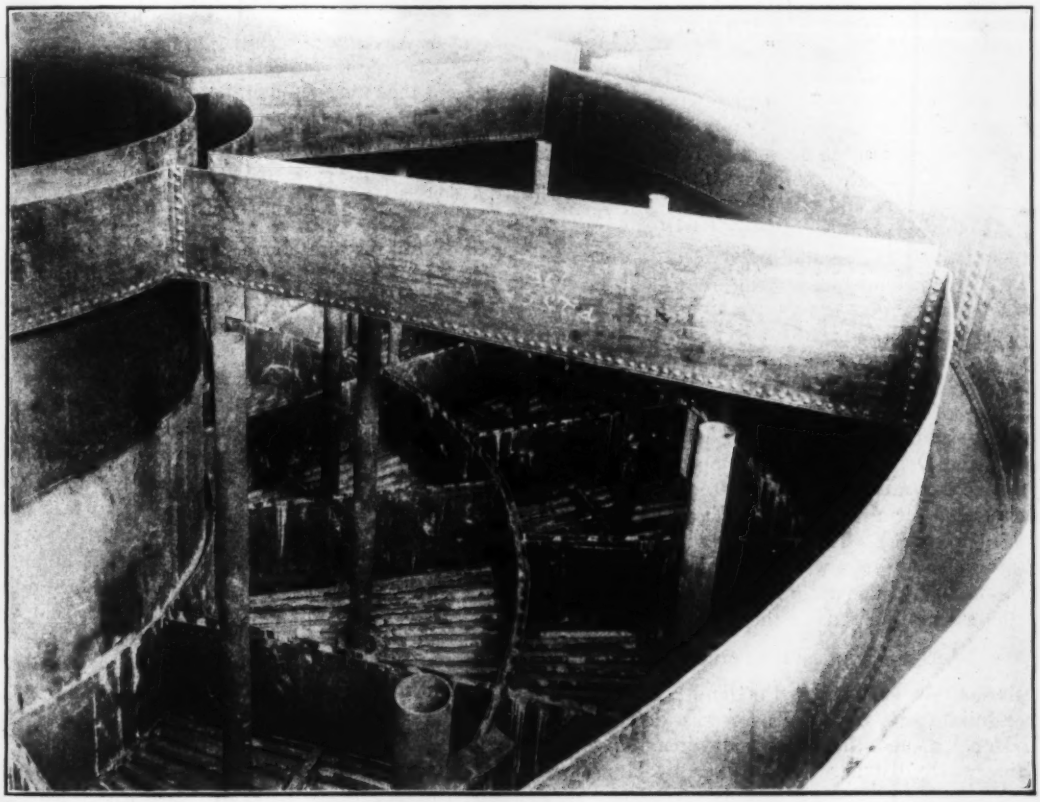


FIG. 6. INTERIOR OF TORONTO FILTER HOUSE, SHOWING A TANK READY FOR GRAVEL AND SAND

Filtered water collection and reverse-flow wash-water system in bottom and standpipe for raw water and washed sand in center of each unit. Sand-extracting ports are placed in the radial and annular walls. Backwash overflow channels above

The filter underdrains and wash-water pipes are of 1¼-in. sherardized steel, 6 in. c. to c., perforated with ⅜-in. holes also 6 in. c. to c. There are 774 pipes and 6,192 holes to each filter.

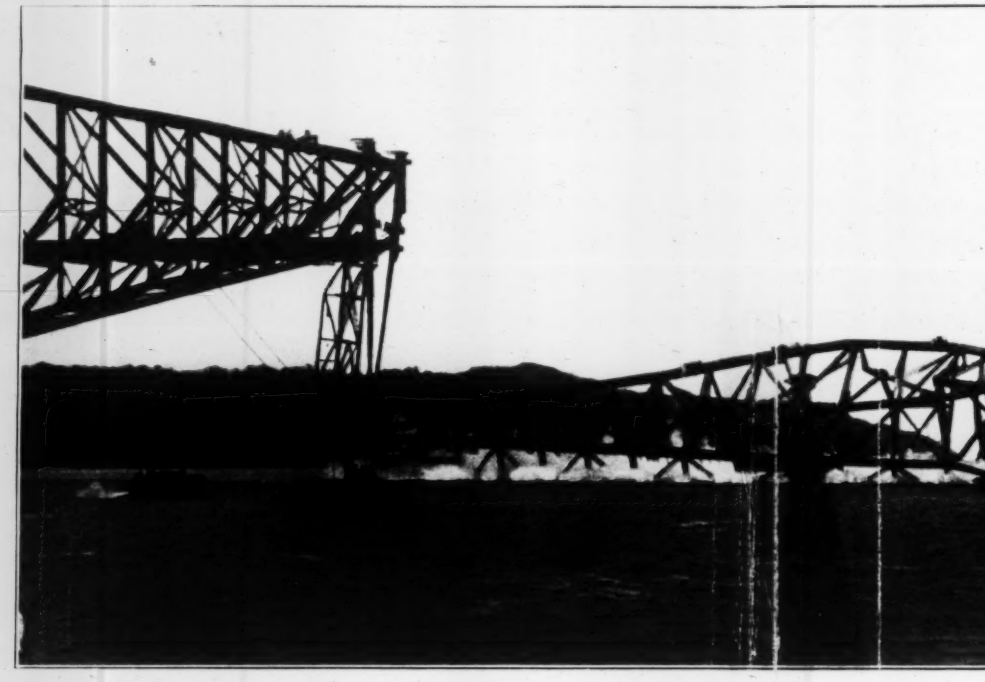
The pumps are all electrically driven. Three 36,000,000-gal. pumps with 32-ft. lift supply the filters, besides which there are a 2,000,000-gal. auxiliary pump with 32-ft. lift, two 500,000-gal. backwash tank pumps with 100-ft. lift, two 1,000,000-gal. drainage pumps with 20-ft. lift and two hydraulic pressure pumps with a capacity of 8,640 gal. a day under 700 lb. per sq.in. All the pump capacities are in Imperial gallons. The discharge of the main pumps is controlled automatically by the level of the water in the filter tanks, through pilot valves operating hydraulic valves on the discharge of the pumps.

The electric current is supplied either by purchase from the Toronto hydroelectric system (from Niagara Falls) or from a steam turbo-generator at the filter plant.

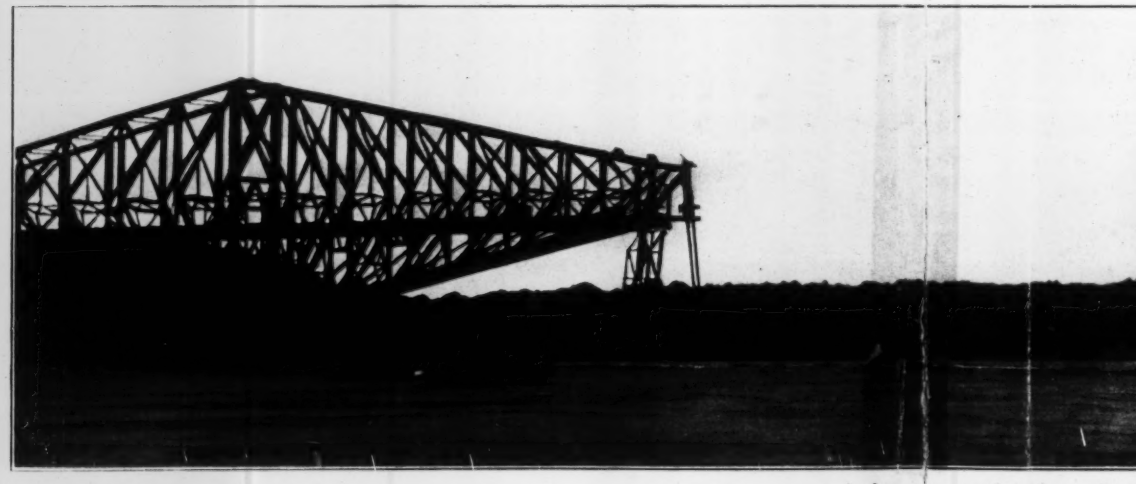
The span linked to the chains and raised clear of the scows, completing the l

The view of the fall shows the southwest corner of the span well under water, and the other four corners still on the hanging chairs. The southwest hanger has been kicked back.

The south end of the span has rotated westward about the southeast seat. The top lateral system has failed except at the north end. The span portals have retained their shape.



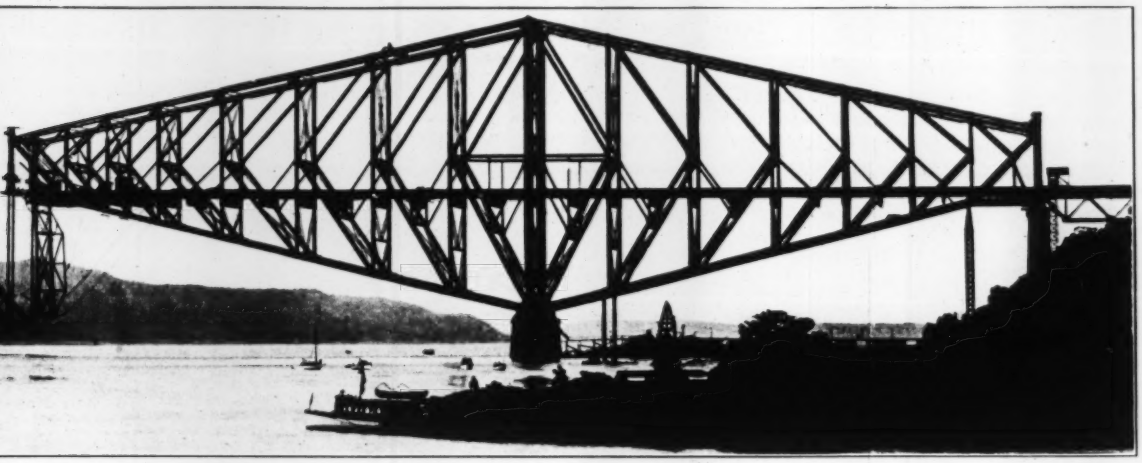
The falling span snapped by a lucky newspaper man—a moment before th



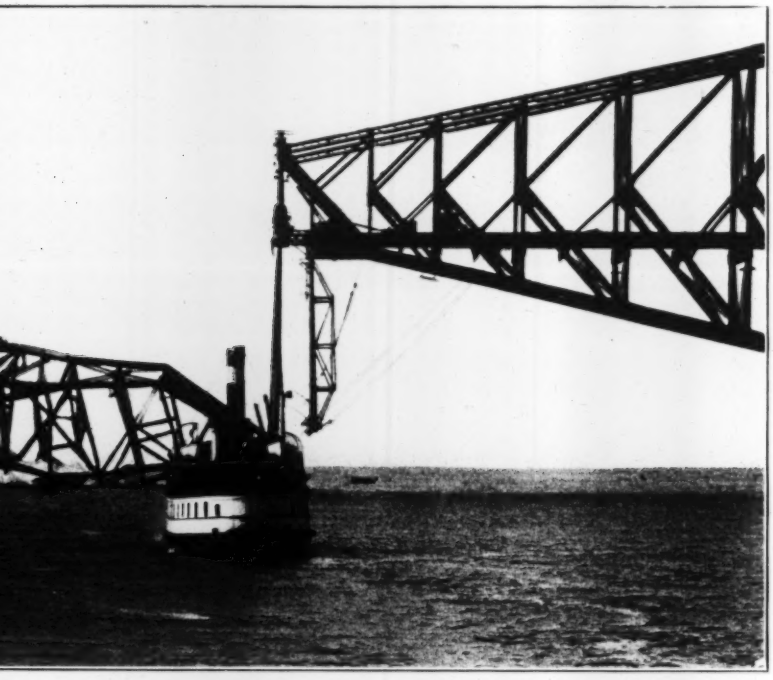
A few seconds after the

Québec Bridge Suspended Span Being Lifted, Sept. 11, 1916. Its
Recorded by Photographs and

show movement straight forward toward



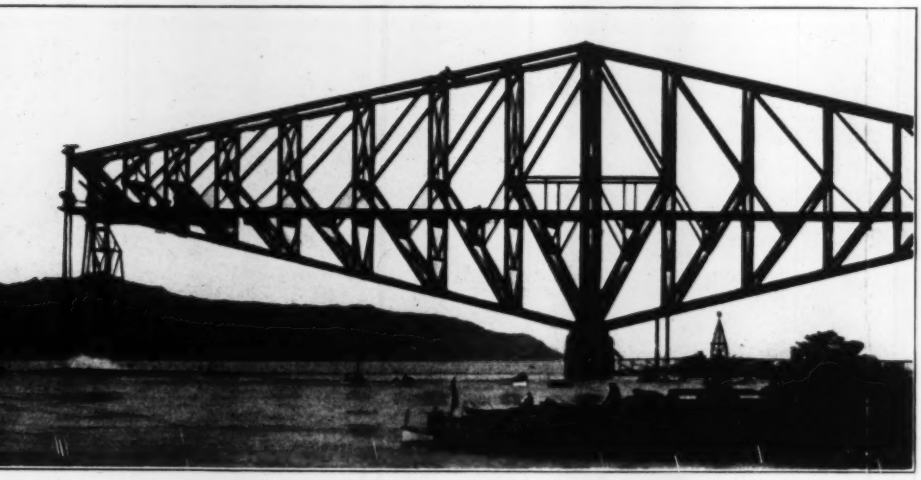
he last hazardous operation in the construction of the bridge.



re the southeast corner of the span tore loose from its seat.

The upper and lower views were taken only a few moments apart. The boats are in nearly the same position. The suspended span went down in the meantime. The broken water in the wake of the span's plunge is still visible in the lower view. Note the violent swinging of the hangers, the south (left) hangers in opposite phase. The splash at the right is falling wreckage from aloft.

Copyrighted by International Film Service Co.

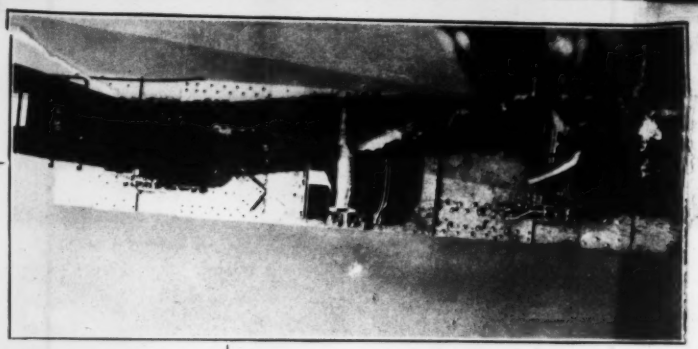


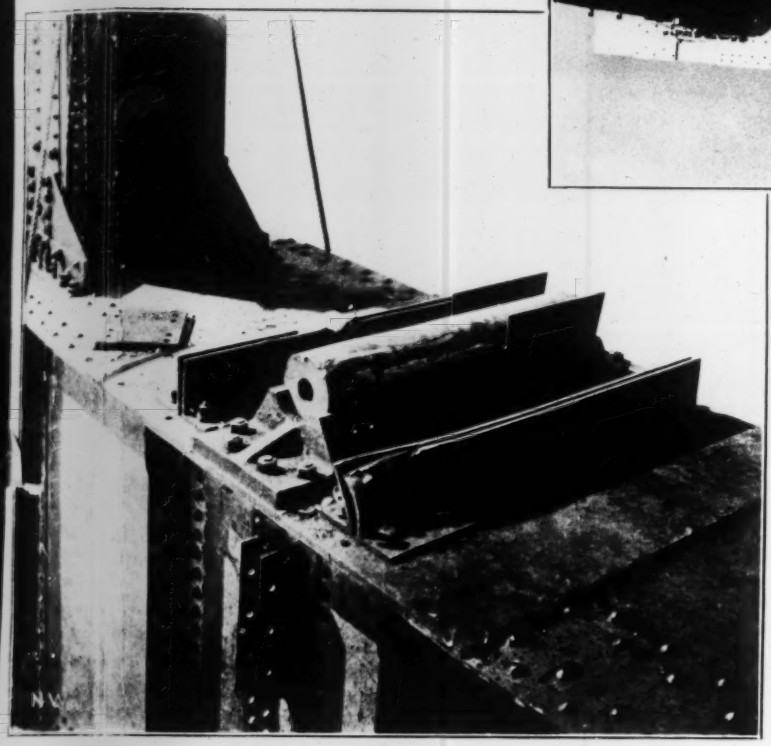
he fall

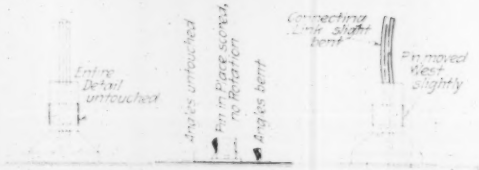
ts Fall. The Tell-tale Marks Left on the Truss Seats nd Sketch Diagram.

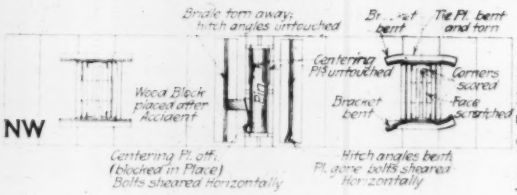
The lifting girders were tipped forward by the pressure of

Both ... seats show movement straight forward toward mid-... after both south ends were in the water, the north ... of the span slipped off their rockers, once the lower ... tal strut was torn past the inner hanger chains.

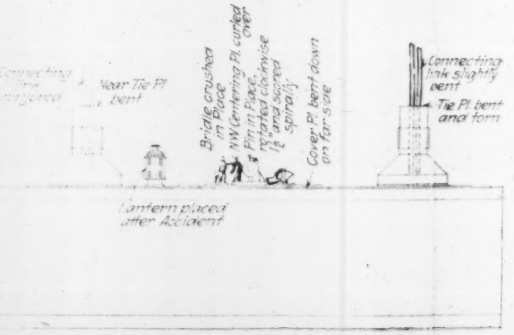


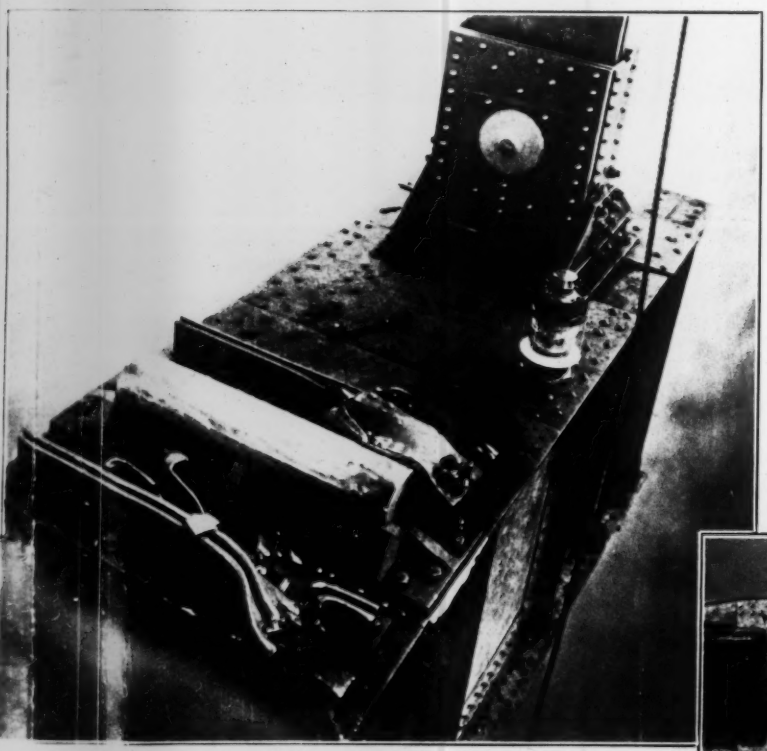


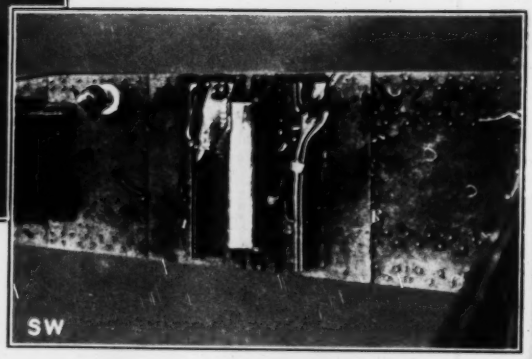




Sheet Lead squeezed out
N.W. Centering plate in place but battered down Vertically, 2 bolts sheared vertically
N.E. Centering plate gone, bolts sheared 45° down
Link corner beveled 45°
SW
2 bolts intact
45° Score on cover Pl.
45° Gash in Angles
Bridle crushed in Place
Tie Pl. bent
Link corner scored
Tie Pl. bent and torn
S.W. Centering plate gone, bolts sheared Vertically
Pin in Place, rotated and scored
S.E. Centering plate free, bolts sheared 45° down


Connecting Link slightly bent
Rear Tie Pl. bent
Bridle crushed in Place
NW Centering Pl. untouched
Pin in Place, rotated clockwise 12° and scored spirally
Cover Pl. bent down on Far Side
Connecting Link slightly bent
Tie Pl. bent and torn
Lantern placed after Accident

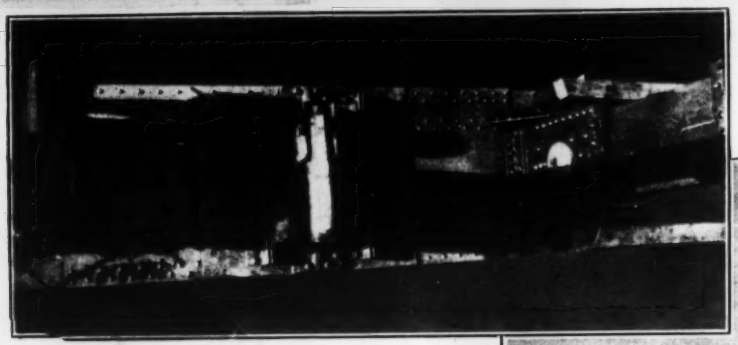




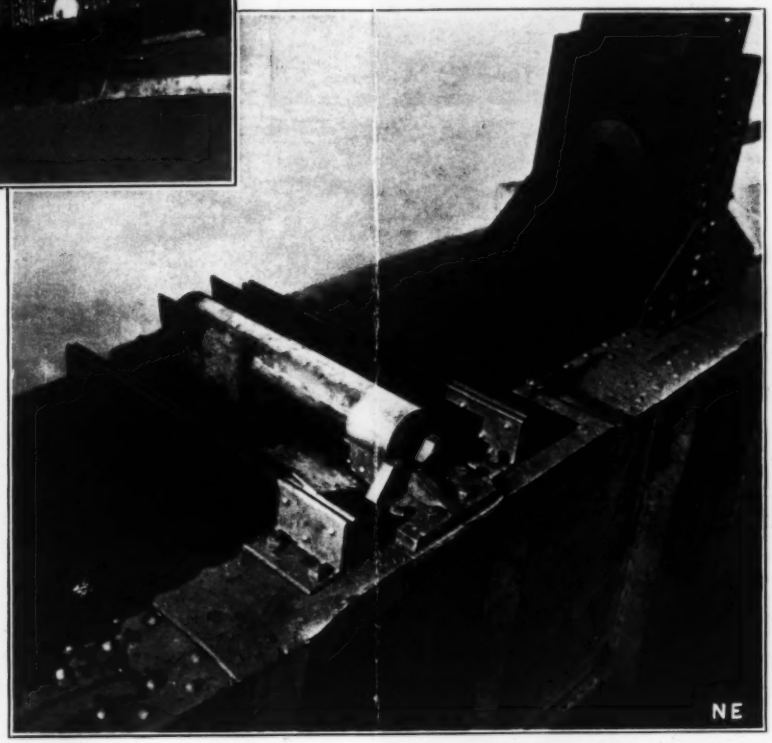
...ocket c... ...g at the southwest hanger broke, dropped this corner of span ...tarted th... ...fall of the span. The truss corner barely grazed the girder.

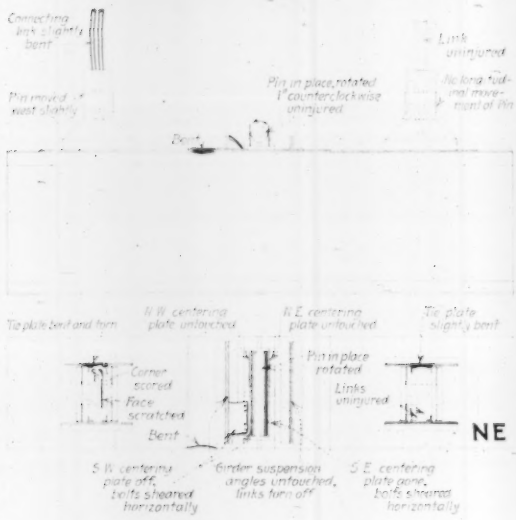
Photographs by E. M. Finn, staff photographer of St. Lawrence Bridge Co.

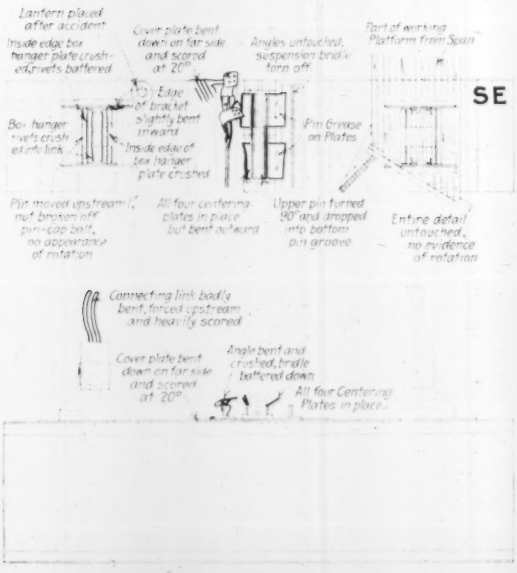
Longitudinal Center Line of Bridge

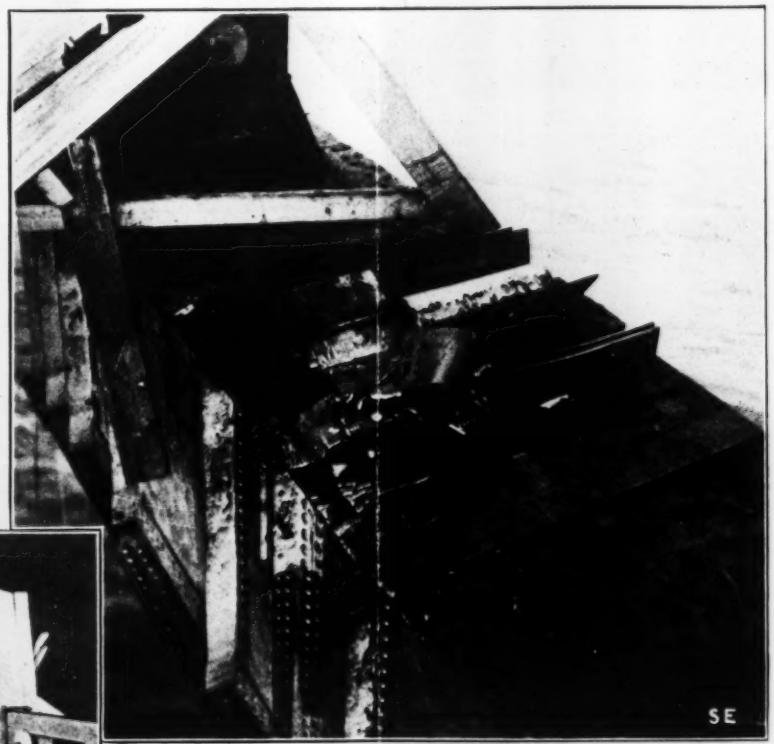


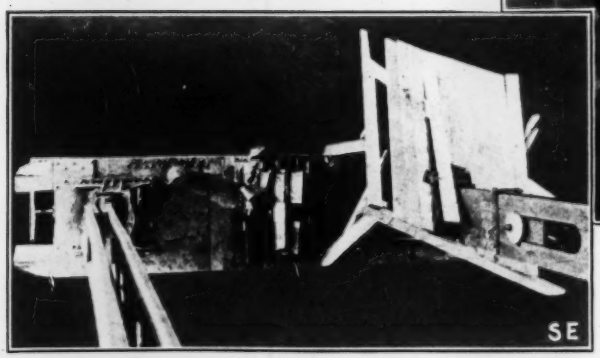
The lifting girders were tipped forward by the pressure of the end strut against the back of the inner hanger chain and the corresponding backward reaction of the shoe. The rear upper tie-plates of the box hangers are bent back.




Connecting link slightly bent
Link uninjured
Pin in place, rotated 1" counterclockwise uninjured
No long'tudinal movement of Pin
Pin moved 4" west slightly
Tie plate bent and torn
N.W. centering plate untouched
N.E. centering plate untouched
Tie plate slightly bent
Corner scored
Face scratched
Bent
Pin in place rotated
Links uninjured
NE
S.W. centering plate off, bolts sheared horizontally
Girder suspension angles untouched, links torn off
S.E. centering plate gone, bolts sheared horizontally


Lantern placed after accident
Inside edge box hanger plate crushed, rivets battered
Cover plate bent down on far side and scored at 20°
Angles untouched, suspension bridle torn off
Part of working Platform from Span
SE
Edge of bracket slightly bent inward
Box hanger rivets crushed into link
Inside edge of box hanger plate crushed
Pin Grease on Plates
Pin moved upstream, nut broken off pin-cap bolt, no appearance of rotation
All four centering plates in place but bent outward
Upper pin turned 90° and dropped into bottom pin groove
Entire detail untouched, no evidence of rotation




Connecting link badly bent, forced upstream and heavily scored
Cover plate bent down on far side and scored at 20°
Angle bent and crushed, bridle battered down
All four Centering Plates in place
SE

The south end of the east truss was turned to horizontal by the fall of the southwest corner; the rocker canted, leaving the centering plates in place.

Diagram sketched by Engineering News and checked by S. P. Mitchell

Longitudinal Center Line of Bridge

The contract requires that the filtration plant shall remove 90% of all organisms where there are 50 to 500 bacteria per cubic centimeter in the unfiltered water; 95% where there are 500 to 2,000; and 98% where there are 2,000 or more in the unfiltered water. The plant must also remove 98% of the *B. coli* as determined by the standard methods of the American Public Health Association.

All turbidity must be removed, leaving a bright, colorless water free from taste. Such results must be obtained by the use of not more than one grain of alum per Imperial gallon of water under average conditions.

At the time tenders were received an alternative design was submitted for the filters being built of reinforced concrete. Such a design shows economy of space and construction cost, but for local reasons the steel design was preferred and adopted.

New England Water-Works Men Do Things at Portland

All things good joined in making a success of the thirty-fifth annual convention of the New England Water-Works Association at Portland, Maine, last week. Business proceedings, excursions on Casco Bay and on Lake Sebago, a clambake, a recital on the great municipal organ in the City Hall resulted in a happy combination of work and play, while the large exhibit of water-works appliances, in charge of genial associate members, was always at hand for a tour of inspection and enlightenment.

A new feature was a water registrar's session at which several papers on accounting and meter records were presented. Two superintendents' sessions were held.

A feature of the opening session was an address by Rear Admiral R. E. Peary, who plead for 16 new fast first-class battleships, an aeronautic department with a place in the Cabinet for its head, and universal military training. Local addresses of welcome were also made at the opening session. In addition, Charles W. Sherman presented the report of the Dexter Brackett Memorial Committee. This committee has raised about $1,200, of which $1,000 had been expended for a medal. (See *Engineering News*, Sept. 7, 1916, p. 478.) The Association adopted rules suggested by the committee, which provided for awarding the medal annually to the author of the best paper presented to the association during the year.

Water-Supplies Described

The water-supply system of Portland, consisting of gravity conduits from Lake Sebago, was described by David E. Moulton, and the history and general scheme of the Maine water districts was outlined by Harvey D. Eaton, of Waterville. A constitutional municipal debt limit established in 1877 was largely responsible for private ownership of all but two of the water-works built in Maine for many years. To get around the debt limit, water districts have been created, consisting of two or more municipalities. Many privately-owned works have been acquired by these districts, but the publicly-owned works are still in the minority.

The new water-supply for Anson and Madison, Maine, is a modification of the district plan, in that the supply main is under joint ownership and the distribution systems under independent town ownership. The new main, divided between wood and cast iron, was described by L. L. Wadsworth, President of the Hanscom Construction Co. Owing to the high cost and poor quality of labor, a gasoline-driven trenching machine and a drag scraper were used for trenching and backfilling. Where quicksand was encountered it was considered cheaper to remove the material that slid in than to sheet the trench.

Service Pipe Materials and Methods

The Water Service Committee of the Association submitted a preliminary report through the chairman, William S. Johnson, of Boston.

As usual, the mere mention of water services gave rise to animated discussion. Desmond FitzGerald said he had a cement-lined wrought-iron service in continuous and satisfactory use for 35 years. F. N. Speller, of the National Tube Co., and James Aston, of the A. M. Byers Co., had a tilt over the relative lasting qualities of steel and wrought-iron pipe, each making a good case from his own viewpoint. Patrick Gear, of Holyoke, remarked in his usual mirth-provoking manner that every superintendents' day some one butts in—if not a fire-insurance man, then a young fellow who wants to sell pipe. He suggested that the superintendents be given the right of way. A. A. Reimer, of East Orange, N. J., urged flexible rather than rigid connections between services and mains, and said that his own men, not highly skilled, made wiped joints that gave satisfaction. W. C. Hawley, of Wilkinsburg, Penn., had given up wiped joints for commercial couplings.

Leakage in Pipe Joints

Speaking for himself alone, F. A. Barbour, of the Committee on Leakage from Pipe Joints, summarized replies to a questionnaire. He first emphasized the lack of co-operation evidenced by the receipt of only a hundred replies or so to questions sent to some five hundred water-works men—and many of the replies gave but little information. Even where all or nearly all the services are metered, 20% of the water distributed is not paid for. It is an open question whether this is due to main and service leaks or to meter slip. It is gratifying to note that the general practice reported is to test new mains before backfilling and to require almost absolute tightness. The reports received indicate that meters are the great factor in conserving water and leakage a relatively minor matter, but there are cases of heavy leakage. Leakage surveys are needed. It was voted to have Mr. Barbour's paper sent to all the members and made the subject of discussion at a later date.

Breaks in Water Mains and Their Repair

Seventeen years' experience with breaks in the trunk mains of the Boston Metropolitan Water-Works was reviewed by S. E. Killam, superintendent of pipe lines and reservoirs. There have been 25 breaks in this period, fairly well distributed by years. Of these, 18 were probably due to slight settlements of cast-iron pipes onto rigid supports. Allowance for settlement should be made and care should be taken not to have solid matter for the pipe to settle onto.

The make-up, equipment and work of emergency repair gangs were described by George H. Finneran, general foreman water service, Boston. The gang is divided into three 8-hr. shifts, provided with a motor car, which can carry 14 men when necessary, besides required tools. The

car is equipped with a gate-closing attachment, driven by the car mechanism. The emergency gang generally reports at all large fires, so as to be ready in case of need.

Grading Water-Works for Fire Protection

The committee on this subject (through Charles W. Sherman) reported for discussion but not for adoption as yet a grading schedule proposed by the National Board of Fire Underwriters, after study by their engineers. The scheme assigns cities or towns to ten classes, according to the number of deficiency points shown after local investigation. The Committee has conferred with George W. Booth, chief engineer, and Clarence Goldsmith, principal assistant, representing the Underwriters, who have agreed to some modifications. Two notable outstanding differences are that the proposed Underwriters' schedule assigns no penalty for overlarge fire service connections and penalizes 4-in. fire hydrants under all conditions. In discussing the report, R. E. Thomas, of Lowell, Mass., said that on the recommendations of the Underwriters, Lowell has spent $300,000 in water-works improvements. Instead of getting fire-insurance rates reduced they have been increased—an experience common to other Massachusetts cities. This, Mr. Thomas thought, is not due to the National Board of Underwriters, but rather to sectional boards in direct charge of rate fixing, not in touch with the water-works side of the matter, as are the engineers connected with the Underwriters. Further discussion indicated that the failure to secure lower rates after water-works improvements urged by the Underwriters have been effected is at least in part due to the bad building laws and risks so prevalent in many cities.

Mr. Booth explained that only recently has a start been made toward classifying fire losses in such a way as to give a working basis for reducing rates as local improvements of one kind or another are made.

Accounting and Records Practice

A classified cash book was described by A. L. Sawyer, registrar of Haverill, Mass., who also exhibited the first cash book of the Haverill Water Co., considerably over a hundred years old. A. W. F. Brown, superintendent, Fitchburg, Mass., showed a three-card meter-record scheme which has been found to serve the needs of that city. A brief paper on water-works accounting was read by E. L. Pride, public accountant, Boston. Besides advocating uniform accounts, the author spoke for a 2% depreciation charge against income, the proceeds to be used to keep the works in shape. In reply to criticisms of a flat rate, regardless of all local conditions, Mr. Pride explained that this seemed more likely than any other plan to secure uniformity. A motion to appoint a committee on accounting led to mention of conferences under the auspices of the Bureau of the Census, some years ago, and a lengthy report submitted to the American Water-Works Association. It was finally voted to appoint an accounting committee, which should consider previous studies of the subject by the other associations, the Bureau of the Census and various utility commissions.

Arguments in favor of the appointment of a committee on standard specifications for water meters were made by R. J. Thomas, superintendent, Lowell, Mass. It was voted that such a committee be created and that it work for uniformity in parts and names of parts. Mr. Thomas gave as one reason for carefully drawn uniform specifications the fact that many cities and towns are compelled by law to advertise for bids and award the contract to the lowest bidder. Where the acceptance of the lowest bid is compulsory there is need for rigid specifications.

Other Papers and Business Matters

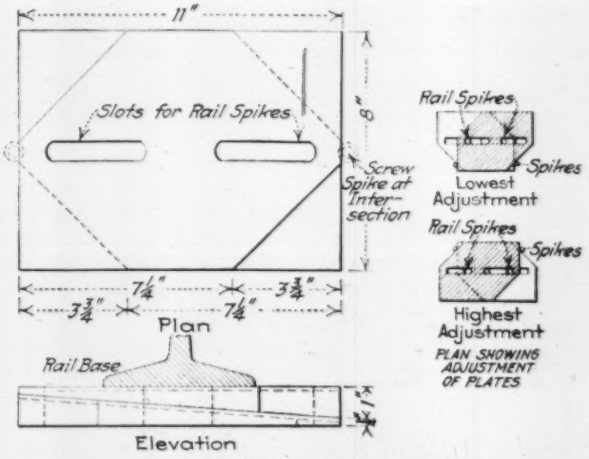
A description of the intermittent use of an excess of coagulant before slow sand filtration at Springfield, Mass., was submitted by E. E. Lochridge, of that city. A general review of the sanitary phases of the public water supplies of New Hampshire was presented by C. D. Howard, chemist State Board of Health. Of the 8 filter plants in the state, 6 use chlorination. Informal remarks on public utility commissions were made by a member of the Maine Commission. He said that such commissions, the utilities regulated and the public should consider themselves as partners. He outlined the need of control of water pollution in Maine in such a way as to suggest that the state is backward in the matter.

During the convention 52 new members were elected. This brings the membership to about 1,050, of which it is said that 150 have been secured this year.

Wedge Tie-Plates for Track Under Turntables

Wedge-shaped tie-plates which permit variation both of the position and of the level of the rail are used to carry the pit rail for the new 100-ft. turntables of the Atchison, Topeka & Santa Fe Ry. The track consists of 90-lb. rails on creosoted ties 5¾x8-in., 36 in. long, laid radially on a concrete wall around the bottom of the pit. On each tie there is a pair of the wedge-shaped plates 8x11 in., having a thickness of ¼ in. at one end and 1 in. at the other end. By driving the upper plate forward or back (at right angles to the rail) the thickness may be varied from a minimum of $1\frac{1}{16}$ in. to a maximum of $1\frac{7}{16}$ in.

The tie-plates are made of both rolled steel and malleable cast iron. The latter cost less and have proved satisfactory. The plates are six-sided in plan and have



TIE-PLATES FOR ADJUSTING TURNTABLE TRACKS

slots for the rail spikes. When adjusted to the required elevation they are secured by a pair of screw spikes against their ends. These tie-plates were devised by A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Santa Fe Ry., in connection with some new turntables.

FIG. 1. AFTER DAWN ON THE MORNING OF MONDAY, SEPT. 11, 1916. THE SPAN BEING FLOATED TO PLACE

The Full Evidence on the Fall of the Quebec Bridge Span

The Inexplicable Accident Fully Cleared Up—A Complete and Accurate Account of the Events Which Occurred from Instant to Instant; with Insert Sheet Presenting a Graphic Record of All the Evidence Left Concerning the Mishap to the Suspended Span

Investigation has revealed a complete and exact record of how and why the Quebec Bridge suspended span fell from its supports on Sept. 11. This record, affording a remarkable picture of the whole mechanism of failure, is found in the condition of parts left at the truss seats on the lifting girders. It seemed at first, immediately after the span disappeared, that no structural evidence could possibly be left to give a clue to what happened. Later, examination of the lifting equipment showed numerous significant injuries and marks, and when the investigation got down to a detail study of the four supporting chairs or "lifting girders," the full story was obtained of what happened in the few seconds from the time the span first started until it had pulled loose from the last support.

A scrupulously detailed sketch memorandum of the examination of the lifting girders was made by *Engineering News*. With the consent of the engineers of the Board and officials of the St. Lawrence Bridge Co., whose observations and findings are in entire agreement with it, this record is here presented. Through excellent work done by the St. Lawrence Bridge Co.'s staff photographer, E. M. Finn, under difficult conditions, it has been possible to illustrate this sketch memorandum in most striking manner by a series of plan and elevation photographs, amplifying and explaining the sketches.

What the record of the lifting-girder conditions tells—so soon as the language that it speaks is understood—is that the bridge first smashed down through the southwest supporting rocker and then skidded diagonally off this seat as the hanger was kicked back southwesterly, and that subsequently at the three other supports it twisted or pulled away. The remarkable photograph shown on our insert sheet, of the bridge while on its way to the water, is in perfect agreement with the story told by the lifting-girder conditions, and makes it certain that this story is not falsified by any incidental subsidiary effects.

The work of making minute examination of the structure to detect any evidence of cause was started within a few hours after the collapse. Engineers of the St. Lawrence Bridge Co. and outside engineers retained by them, as well as members of the Board of Engineers, took part in these examinations. On invitation a completely separate survey of the conditions was made by one of the editors of *Engineering News*. The St. Lawrence Bridge Co. facilitated this examination in every possible manner, providing equipment needed for lowering over the ends of the cantilevers and giving assistance as asked. Largely through this ready accommodation, it is possible to present the results of this examination in the complete and graphic form presented by the insert sheet of this issue. The results given by this sheet have been subjected to careful check and are known to be correct.

Condition of Hangers

Before examining the exhibits of the condition of the lifting equipment, it is necessary to have well in mind how the span was supported on the lifting girders across the end of each pair of chains. Briefly, on the top of the girder there was a steel shoe casting with a longitudinal pin groove, carrying a 9½x46½-in. pin parallel to the line of the bridge. On this pin was seated the suspected steel rocker casting, which in turn carried a short transverse pin, 8x26¾ in. The upper shoe, attached to the base of the end post of the span, rested on this transverse pin.

This detail served as the universal joint needed during the five weeks that the suspended span stood on its end supports at Sillery, awaiting the day of floating and hoisting. When the span finally was supported by the scows, the lifting girder was no longer supported from below, and therefore was hung by a pair of bridles from the upper shoe. To keep the castings in proper central bearing when the hangers picked up the lifting girders,

four centering plates were bolted to the bottom casting and carefully fitted (in the shop before erection of the span) into the inner corners of the cruciform rocker, and matchmarked. Placing these centering plates was one of the last jobs before the span was towed out. They were inspected by Mr. Porter, the engineer of construction, and Mr. Mitchell, the consulting engineer of erection.

For an appreciation of the condition of the hangers after the accident, it is necessary to remember that the two double hanger chains coming down to each corner of the span were made up of heavy slabs (as noted in detail in *Engineering News*, Aug. 31, 1916), ending in a slotted bottom link and below this a connecting link pinned into a box-girder hanger built into the lifting girder.

Evidence from Condition of Southwest Hanger

Descending the southwest hanger, the condition of the top of the lifting girder was as noted in the insert plate of sketches and photographs. The most prominent thing observed was that, of the four centering plates, the northwest plate was in place but crushed down vertically with two of its bolts sheared off vertically and two intact. Alongside of it was the girder suspension bridle, in place, also crushed vertically. The southwest centering plate was missing, but its bolts had been sheared off vertically, also indicating the descent of some vertical load upon it. Probably both northwest and southwest plates were crushed down by the same action, and their different behavior is due to incidental effects.

The presence and condition of these two centering plates really is the key to the whole evidence on this hanger. It proves that there could have been no departure from normal conditions up to the moment some vertical blow was delivered to the west centering plates of the

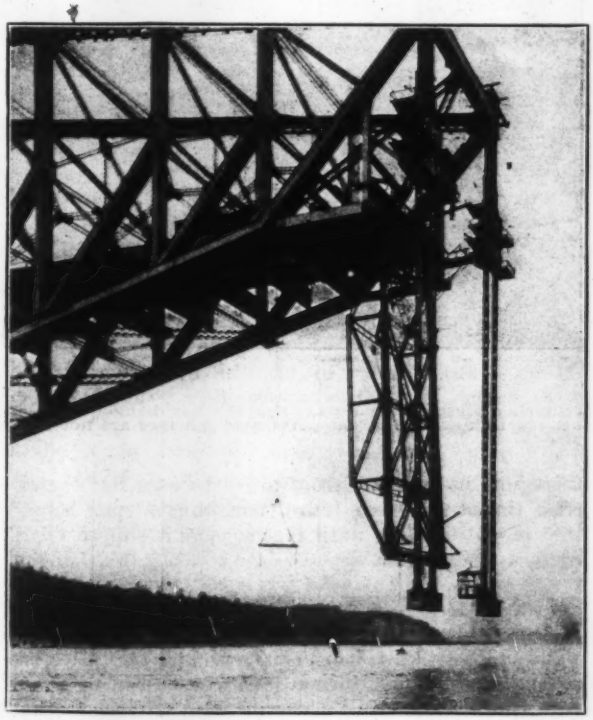


FIG. 2. NORTH HANGERS AFTER FALL OF SPAN
Showing cage used in reaching lifting girders

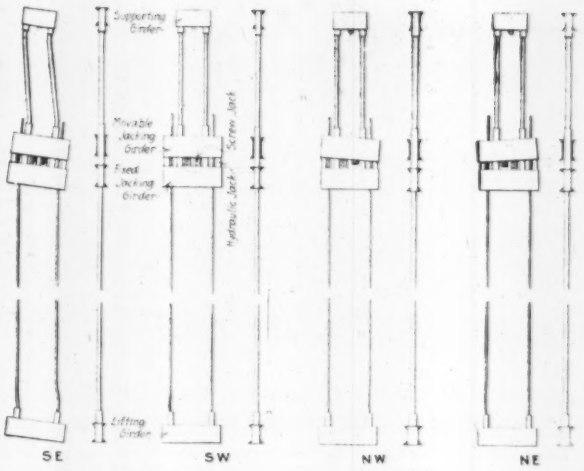


FIG. 3. DIAGRAM SHOWING HANGERS AFTER ACCIDENT
On all hangers the screw jacks were being run up as the hydraulic-jack plungers were coming down. But on the north side jacks—due to the shock or to the screw operators' grasping the handles—one of each pair of screws spun up and allowed the top jacking girder to settle out of parallel with the lower one

southwest hanger. These plates are the only points on any of the hangers where direct vertical action is indicated—all else shows a combination of turning, twisting and sliding. The vertical injury to these two plates must have preceded all other effects noted elsewhere.

The other two centering plates at this hanger showed the bolts sheared downward and forward (i.e., toward the suspended span) at 45°; the southeast centering plate was free and the northeast one was missing. These conditions indicate backward movement of the girder occurring on the east side of the pin simultaneously with the dropping of the truss shoe.

The lower pin was in place, but rotated eastward on top 1½ in. and scored spirally, indicating backward movement of the girder and crosswise movement of some superimposed burden. The east bridle hitch angles close by showed a deep 45° gash, indicating the same movement as shown by the pin.

The south tie plates on both the box hangers were found bent by contact against the connecting link of the hanger chain, the easterly one being the more damaged. These bent plates indicate positively a strong rotation of the lifting girder. The inner (east) chain shows a scored edge, which can be explained by the chain's shearing through the bottom end strut between trusses. This end strut consisted of two ribs each made up of a 54x⅝-in. plate and two 6x6x⅝-in. angles, and the inner chain passed through between the two ribs; before the span could separate from the lifting girder or hanger chains, the inner chain had to tear its way out through one rib of the end strut.

How the Wreck Started

The earlier steps of the accident are made apparent by the just-described conditions at the southwest hanger. Something must have broken in the northeast quarter of the shoe detail. It could have been only the intermediate or rocker casting (see sketch Fig. 5 and view Fig. 4). The fracture most probably occurred near the root of the front lower pin-bracket of this rocker, putting the bearing on the lower pin out of service; and in all likelihood

the fracture entered the upper pin seat and one of the upper brackets also.

Concentration of the enormous 1,200-ton load on the fracture edges must have caused crushing, tipping of what was left of the rocker, and some backward movement of the lower shoe and lifting girder.

It was incidental to this quickly-passed stage of the catastrophe that the westerly fragment of the rocker bore down on the two west centering plates, curling one of them over and forcing the other off by downward shear. In the same action, however, the fragments of the broken rocker were ejected from between its two pins like a smooth wet orangeseed, and, the impulse kicking back the entire swinging girder, the corner of the span fell free, only grazing the pin and the girder cover-plate as it went off.

These events, written in the markings on the southwest girder, make all the other actions subsidiary. And, indeed, the examination of the other three hangers shows the very actions there that must follow from the starting of the fall as just sketched.

The Southeast Hanger

Some parts of the southeast hanger were severely punished, while others escaped very easily. Some 8 ft. above the girder top the inner hanger chain was badly bent, forced to the west, and heavily scored. The pressure accompanying the movement at this point is indicated by signs of high local heating of the steel in the score marks on the inner hanger chain.

The pin in the box hanger was moved west 1 in., but showed no signs of rotation. The top inside edge of the west plate of the west box hanger was crushed, and the box rivets were forced into the link. The south bracket at this box hanger was untouched, and the north bracket had its east edge only slightly bent inward. The corresponding detail at the east box hanger is entirely untouched.

Looking at the lower shoe detail, it is seen first that all four of the centering plates are in place and bent outward. On both the east plates are found large splashes of pin grease, and the direction of these splashes indicates that some turning of the rocker casting must have neatly spooned the lower pin out of its pocket. The turning of the casting undoubtedly bent down the westerly plates, and the pin forced over the easterly pair. Remarkable to record, the upper pin lies in the lower pin bearing; to drop into this position it must have turned 90° from its original direction. The crushed and bent-in west bridle hitch angles and bridle are further evidence of this action. The bent and scored edge of the girder cover plate nearby marks the final path of the edge of the truss end post as it left the lifting girder.

What happened at the southeast hanger is easily understood. The photograph of the falling bridge gives a perfect picture of the action, the same as read out of the conditions of damage. The overturning west truss, through the action of the portal and top laterals, twisted the end post of the east truss to the westward and down. The bottom end strut, already torn loose from the west truss when that ripped through the hanger chain, offered no resistance to the tipping movement. The truss was tilting on its lower rocker pin at the start, and after reaching the limit of the rocker's turning freedom it canted and slid on the transverse pin, forced the rocker out backward and eastward, and dropped the upper pin, now vertical, into the lower shoe, where it dropped into the bearing. The end post now was on the point of slipping off, having in the meantime banged heavily against the inside face of the west hanger; it dropped to the river, hardly touching the top of the lifting girder. The blow from the end post, possibly supplemented by downward pressure from the end strut, tilted the whole girder series of the hanger about the longitudinal supporting pin on top of the upper chord of the cantilever arm. But

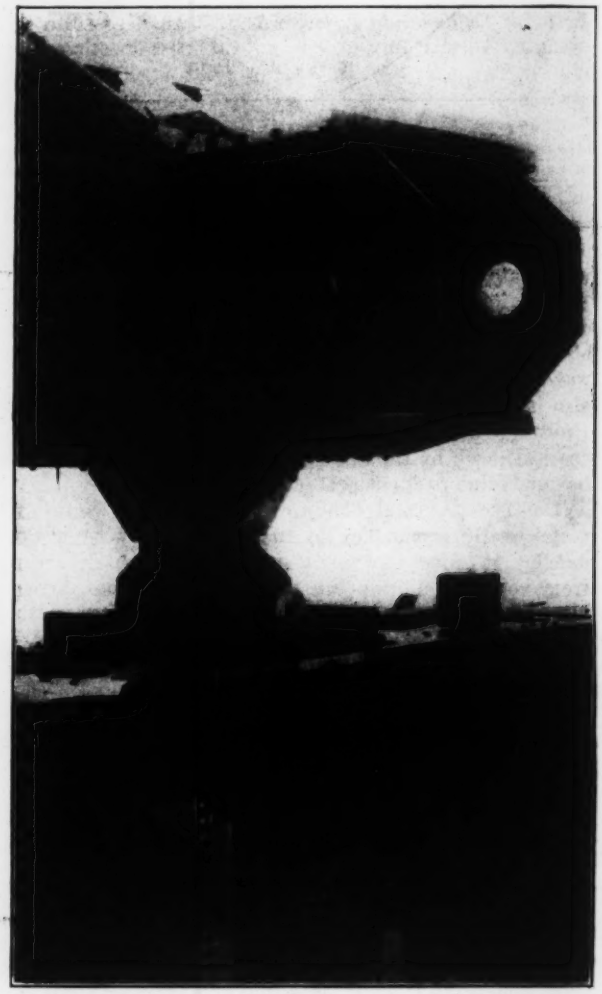


FIG. 4. VIEW OF ROCKER IN PLACE

At Sillery, on falsework; incomplete. The bridles and centering plates are missing, and the box hanger and connecting link as well as the permanent hangers are not yet in place

there was no rotation about an east-west axis; the east truss tipped purely westward, remaining a span between its two end bearings until the moment it slipped off the southeast bearing.

Condition of the Two North Hangers

Almost identical pictures were presented by the northwest and northeast hangers: Lower pin in place, apparently not rotated, its top half wiped clean of grease; rear (north) centering plates in place untouched; front centering plates gone or at least torn loose, and showing horizontal shearing of the bolts; and practically no other

damage except to the respective inner hanger chains, which had to tear out through the end strut. The movement of the north end of the span was evidently straight forward, in the direction of midspan. As might be expected, both lifting girders tipped forward during the fall; the northeast one shows the strongest evidence of tipping.

The north mooring span was appreciably warped; the lower end was rotated clockwise, probably from the sequence in which the four mooring lines parted. This damage appears to have no relation to the other evidence or to the cause of the fall.

At the northwest hanger, the two forward centering plates were gone. The bridles were gone; the east bridle hitch angles had the south end bent inward slightly. The west hanger chain was untouched. At the east chain the connecting link was slightly bent to the west, and the pin through the box hanger was moved a bit to the west. The edges of the bracket plates on this box hanger showed some damage. The upper edges of the rear tie-plates on

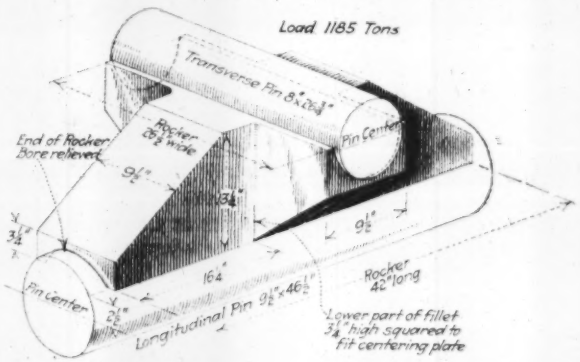


FIG. 5. SKETCH SHOWING DIMENSIONS OF ROCKER
Low-carbon steel casting

both box hangers had come into contact with the link, showing rotation. The rocker pin had longitudinal scratches and its front end was scored.

On the northeast lifting girder the southeast centering plate was gone, and the southwest plate off but lying nearby. The cover plate of the girder showed a small bend at its front edge. The east hanger chain was undamaged except for slight bending of the rear tie-plate of the box hanger, which had come into contact with the connecting link by rotation of the girder. The west chain showed the same effect more strongly, the tie-plate being bent and torn; here the outer rear corners of the connecting link were scored. The link also had a bend to the west, and the pin through link and box hanger was pushed westward a trifle.

The Fall of the Span a Simple Sequel to Failure at the Southwest Support

The above description of conditions tells its story fully. When the southwest support moved away from under the span, the long and heavy 640-ft. span could not maintain its integrity; its laterals, sways and portals were incapable of holding it together when resting on only three supports.

That the span kept up its integral action long enough for complete failure of the south end to precede the fall of the north end, however, is excellent testimony to its good construction. In this respect the photograph of the falling mass and the investigational evidence are in most perfect accord. The photograph caught the moment just preceding the dropping of the southeast corner, and it shows the north end still maintaining full alignment and verticality although both trusses are practically horizontal at their south end and the lateral system is completely wrecked.

Coming to a period a few moments later, the happenings are recounted by the story recorded on the lifting girders. The north corners remained in place until the south end had cleared entirely and was falling free, and then they both slid off forward into the stream. Only a slight twist had been transmitted through the bridge, just enough to let the lower end strut crowd the inner chain of each hanger over to the west and by the same impulse push the pin of the box hanger in westward direction.

Strength Exhibited by the Three Rockers

A point of great moment, in view of the failure of the southwest rocker, is the clear evidence that lies in the investigational findings as to the behavior of the other three rockers. These rockers remained intact throughout, as is amply proved by the absence of severe punishment to the girder cover plate, hitch angles, and shoe. They held the truss corner high above the lifting girder so that it slid off without touching the girder, or at best barely grazing it. Yet these rockers were subjected to a severe duty. The southeast rocker had to carry, in addition to its normal load, an extra reaction great enough to wreck the portal and lateral system of the bridge, and the unknown impact produced by the start of the failure. At the same time it was subjected to extreme canting and tipping actions, continued to the point of concentrating the whole load on one corner and forcing the rocker out of its seat. The north rockers bore nearly as severe a tipping effect, and they too held up intact.

The span rested on these same rockers for five weeks at Sillery, and they bore variously in that time about 10% more load than they carried during the hour and a half in which the span was suspended from the cantilever arms before its fall. This extra load was due to a very heavy material track (removed before the floating) on which ran a locomotive crane and material cars.

The destruction of the southwest rocker therefore did not develop from inherent weakness in the design, even though the rocker may have been overstressed (on the commonly-used assumption of uniform load-distribution along each pin, the maximum tension in the base would be computed at about 30,000 lb. per sq.in.). Defects in the southwest rocker made it weaker than its three mates.

Bridge Company Will Rebuild

Very shortly after the Quebec Bridge suspended span fell—as soon as the officials of the St. Lawrence Bridge Co., the members of the Board of Engineers of the Quebec Bridge, and the Government officials could confer—the bridge company announced that it would accept the responsibility of the accident and bear the expense of replacing the lost span. The company also announced that no changes of moment would be made in the design or the method of erection, floating and hoisting. At the same time it is certain that the detail in which the accident started will be considerably modified.

Orders have already been placed for steel and it is probable that, owing to the emergency, the bridge company will secure quick deliveries.

News of the Engineering World

Correcting the Area of the Croton Watershed

Hydraulic engineers in making computations requiring data of rainfall and runoff in connection with the design of works for water-supply, stream storage, etc., have for many years been accustomed to make use of the data obtained by the long period of observations on the Croton watershed. Very great importance attaches therefore to the announcement just made by the New York Department of Water Supply that a material change has now been officially made in the area of the Croton watershed. The official figure for that area will hereafter be 375 sq.mi. in place of the 360 sq.mi. which has been hitherto used in most computations.

We are indebted to Wm. W. Brush, Acting Chief Engineer of the department, for an interesting historical review of the changes in official measurements of the Croton watershed which have been made in the past three-quarters of a century. The first survey of the watershed of which the department has present records appears to have been made in 1857-58. The annual report of the Croton Aqueduct Department, dated Jan. 3, 1859, contains the following statement:

> The total area or watershed of the Croton above the commencement of the aqueduct is ascertained to be 352 sq.mi.

A map prepared as a result of this survey, however, in about 1860, which was lithographed by J. Bien, then of 24 Vesey St., bore an inscription that the total area of the watershed was 338.82 sq.mi.

This latter figure appears to have been generally used for many years. Need of a more certain determination of the area, however, was brought to the attention of the Aqueduct Commission in the early '80's, and a new topographic survey of the watershed was authorized in January, 1889, in charge of the late W. E. Worthen.

Mr. Worthen will be remembered by the older generation of engineers as the President of the American Society of Civil Engineers in 1887, and for a short time Chief Engineer of the first New York City rapid transit commission. His principal assistants were C. C. Vermeule and J. R. Bien. The map made as a result of these computations was finally delivered on July 24, 1889. The area of the watershed was determined from this map by carefully scaling the parallels of longitude and latitude, using the graphic scale on the map, computing the areas of the various zones, and adding to them the planimetered areas of the irregular portions along the borders of the watershed. As a result the following areas were obtained:

Area of new Croton watershed.....	375.815 sq.mi.
Area of old Croton watershed.....	352.84 sq.mi.
Area of watershed between old and new dams..	22.975 sq.mi.

Controversy immediately arose as to the accuracy of these newly determined areas, which made a material change in the figures so long used. After this survey and map had been made, the site of the new Croton dam was moved slightly upstream. The adopted area of the new Croton watershed was changed to 360.44 sq.mi. A number of the engineers of the Aqueduct Commission, however, were not satisfied that this figure was correct, and from 1900 to 1903, the commission officially used an area of 373 sq.mi. as a compromise, but later returned to the 360.44 sq.mi. previously used.

In 1909 it was determined to measure more accurately than by scaling the area of the watershed as determined by the Worthen survey. The area of the zones of latitude on the Worthen map was determined by computation, assuming the earth to be a sphere 40 million meters in circumference at the sea level. The area of the irregular border of the watershed was determined by the planimeter. One meter was taken as equivalent to 3.280869 ft. The resultant area was 374.979 sq.mi. Another computation of the area was made at the same time, using the Clark's equivalent method adopted by the U. S. Coast and Geodetic Survey. This gave the area as 375.55 sq.mi.

Since 1909 this matter has been given consideration from time to time, and in the early part of the present year it was agreed by all the engineers now in the Board of Water Supply who had taken part in the investigation that an area of 375 sq.mi. should be adopted officially as the area of the Croton watershed.

The above is an interesting illustration of how hard it is to kill an error. The area of 360 sq.mi., which has so long been used, had its sole foundation in the printed figures appearing on the lithograph copy of the map of 1858. This figure was an error as is proved by measuring, by computation and planimeter, the lithograph map itself and also by errors found in the table of subdivisions given on the lithograph. In one case an area is given as 75 sq.mi. which should have been 85 sq.mi. The now officially adopted area of 375 sq.mi. is shown to be correct not only by the Worthen map of 1889, but by the map of 1858 when both are accurately measured. The alteration of this figure may necessitate corrections in many of the standard treatises on various branches of hydraulic engineering.

New Municipal Bridges for Kansas City, Missouri

The St. Louis & San Francisco Ry. and the Missouri Pacific Ry. have both agreed with the Board of Park Commissioners of Kansas City, Mo., to pay one-third the cost of a new bridge and viaduct in Swope Park. The railroads will divide their one-third share in proportion to the width of right-of-way of each. The Park Commissioners have ordered J. A. L. Waddell & Son, who prepared the preliminary plans, to hasten the detail plans and specifications so that a contract can be let this fall.

The total length of the bridge will be 700 ft. It will provide a 40-ft. roadway with a 7-ft. clear sidewalk on each side. The bridge will be an ornamental reinforced-concrete arch structure with a central span of 120 ft. over the Blue River. This arch will be flanked by two 100-ft. arches, the one on the west side spanning the railway tracks. There will also be two 60-ft. arch spans at each

end. The approaches at either end will be cantilevered from the abutments. The estimated cost is $160,000.

The Board of Public Works opened bids on Sept. 26, for three bridges, the first work to be contracted for from the $450,000 bond issue voted over a year ago for bridges and viaducts. One of these will replace the present steel-truss highway bridge over Brush Creek on Troost Ave., and will be 126 ft. long. It will be a reinforced-concrete arch with a clear span of 71 ft., providing a 42-ft. roadway for a double-track car line and highway traffic, and a 7-ft. sidewalk on each side. The estimated cost is $20,000.

A second of the proposed bridges will carry a part of 26th St. over McGee St. Trafficway by means of a reinforced-concrete arch of 80-ft. span. There will be a 17-ft. brick-paved roadway and a 5-ft. sidewalk on the south side. The estimated cost is $14,500.

The third structure will carry 31st St., which is now being graded, over Wyandotte St. and Penn Valley Trafficway. It will be on a slight skew and about 94 ft. long. There will be two rows of columns supporting a 51-ft. girder span and cantilever beams for the approaches at each side of 18 and 25 ft. The roadway will be 36 ft. wide and carry two car tracks, and there will be a 7-ft. walk on each side. A stairway at one side will accommodate pedestrians. The estimated cost is $11,700.

The plans for these structures were drawn by V. H. Cochrane, in charge of the bridge department of the City Engineer's Office. Plans for a number of other structures of similar size are in course of preparation, while two or three large viaducts are being planned for the city by private engineering firms.

Concrete-Bridge Patent Called Invalid in Lower Court

In a decision handed down Aug. 28, 1916, Judge Sater, in the United States District Court, Southern District of Ohio, Eastern Division, ruled against two of the reinforced-concrete bridge patents held by Daniel B. Luten, of Indianapolis. The suit was by Mr. Luten against William F. Whittier *et al.*, for infringement of patents in the construction of two highway bridges in Delaware County, Ohio.

The plaintiff charged the defendants with infringement of three of his patents. As the trial progressed, the plaintiff withdrew his charge as to patent No. 853,202, issued May 7, 1907, for the reason it was manifest that, if the patent is valid, it had not been infringed. The court, after learning that all the evidence pertinent to patent No. 1,070,903, issued Aug. 19, 1913, on a reinforcing bar, had been introduced, decided from the bench that it had been anticipated, lacked both novelty and invention and is invalid. The anticipations were the United States patent to Hyatt, No. 206,112, United States patent to Thacher, No. 617,618, and British patent to Hyatt, No. 289 of 1877.

There remained patent No. 853,203, issued May 7, 1907, which is in effect a patent on a reinforced-concrete spandrel-wall arch in which the reinforcement of the rib and the spandrel walls is continuous. In regard to this patent Judge Sater ruled partly as follows:

This patent and others were before the District Court of Colorado in the case of Luten vs. Washburn et al.[1]. A copy of Judge Lewis' opinion is before me. He reached the following conclusion:

On consideration of prior patents and publications introduced by the defendants to meet the separate and several claims, I am unable to rid myself of the firm belief and conclusion that each and all of complainant's claims were non-patentable at the time he made his several applications and also at the two times prior to applications when he claims he first, within two years prior to such applications, made practical use of the claimed inventions in those two instances. The prior patents as anticipations and the prior patents and publications as showing the then state of the art lead to the clear conviction that complainant in each instance only then made application of mere mechanical knowledge and skill, and that what he did is in no sense a demonstration of inventive genius.

I concur in the conclusion thus reached. An analysis of the prior patents and art will not be undertaken. The development of the art of reinforced concrete began about 1870 and was much pressed about 1890. Some of the patents to which allusion may be properly made are the French Monier patent, No. 77,165 (1873); Monier's American patent No. 486,535 (1892), and especially Fig. 19; Hinckley, No. 623,904 (1899); Von Emperger, No. 583,464 (1897); Brannon's English patent No. 2,703 (1871), especially Fig. 11; Hyatt's English patent No. 2,968 (1877), especially Fig. 3-A; Hennebique's English patent No. 8,814 (1900); and Bone, No. 705,732 (1902).

In some of the patents the horizontal rods are connected to those extending up into the spandrel by ties or other means, so that the inventor employed two rods to accomplish what Luten did by one continuous rod, but the union of two rods into one by welding or casting them together does not rise to the dignity of invention. Monier, at an early date, indicated that his devices might be used in bridge building. He adapted them also to the making of flower pots and the like of that, but his inventions related to the concrete art, and in view of Fig. 19 of his American patent No. 486,535 there was nothing left for Luten but the application of the ordinary skilled mechanic trained in the art.

Other patents of an anticipatory nature might be mentioned, but it is not deemed necessary. A number of decisions in uncontested cases have been submitted, in which decrees were taken in favor of Luten. The manner of obtaining such decrees is too well known to lend importance to them, and the view entertained by this court touching such decrees is the same as that of Judge Lewis in the case of Luten vs. Washburn et al.

An order may be taken dismissing the bill.

Mr. Luten was represented by Arthur M. Hood, of Indianapolis, and the defendants by Edward N. Pagelsen, of Detroit.

[1]See "Engineering News," Dec. 2, 1915, p. 1094.

Santa Monica, Calif., Buys Water-Works—The city commissoners of Santa Monica, Calif., have purchased the plants of four water companies, now serving the city, for a total of $712,500.

A Bridge Across the Hudson River below any now existing is projected at Castleton, 10 mi. south of Albany, by the Hudson River Connecting R.R. Co. A public hearing on the proposed bridge is to be held by the U. S. Engineer Officer at Albany on Sept. 25.

Paving Bids in Competition with Contractors will be submitted by the City of Santa Monica, Calif., hereafter. The Board of Commissioners has given notice that if the city's bid brings it the award of the contract, only Santa Monica workmen will be employed.

Scarcity of Labor is claimed to be so acute in the Middle West that no contractors can be found to make bids on some of the Illinois state-aid roads. Recently work on four contracts, three in Greene County and one in Edwards County, has been held up by not having attracted a single bid.

Concrete Road Building—Figures recently compiled by the Road Bureau of the Portland Cement Association indicate that in each of the five states, Illinois, Ohio, Indiana, New York and Iowa, contracts have so far been awarded this year for over one million square yards. In Michigan, Wisconsin, California and Texas over 500,000 sq.yd., each, are contracted for. Most of the yardage in Iowa is for city streets, while the greater part of the yardage in the other states is for country highways.

A Serious Gasoline Shortage in 1917 was predicted by W. R. Hamilton, of San Francisco, in a paper presented at the Arizona meeting of the Institute of Mining Engineers last week. The only possible means of increasing gasoline production, he said, are an increase in the production of the lighter petroleums, increasing the gravity of gasoline on the market, or innovations in refining methods. He believed that such increases as were likely to occur from any if these causes would be inadequate to keep pace with the steady increase in demand.

An Experimental Water Filtration Plant at Detroit, Mich., is being built to determine at what rate the water could be handled by mechanical filters and to serve also as an educational exhibit. The raw water is low in turbidity and bacteria and is relatiyely soft, but its sanitary quality could be improved by filtration and if lime and sulphate of iron were used as chemical reagents same softening would be effected. Theo. Leisen is general superintendent of the Detroit Water-Works and R. Winthrop Pratt, of Cleveland, Ohio, is consulting engineer for the test plant.

Large Cooling Tower—What is believed to be the largest natural draft cooling tower so far built has recently been completed at the Anderson, Ind., plant of the American Steel and Wire Co. This tower is of the Wheeler-Balcke type built by the Wheeler Condenser and Engineering Co., of Carteret, N. J. The tower is approximately 150 ft. long, 50 ft. wide and 75 ft. high and has a yellow-pine frame with cypress sheathing and filling. The tower has two chimneys which rise above the cooling stacks and create the air circulation by natural draft. The capacity of the tower is 7,300 gal. per min. cooled from 115 to 85° F.

The Minnesota Joint Engineering Board has just been formed with the hope of making the various engineering societies in the state of more value to their several communities. The constituent societies represented on the board are the Northwestern Association of Members of the American Society of Civil Engineers; the Minnesota Section of the American Society of Mechanical Engineers; the Minnesota Section of the American Institute of Electrical Engineers; the Minnesota Surveyors' and Engineers' Society; the Engineers' Club of Minneapolis, and the Civil Engineers' Society of St. Paul. George W. Rathjens, of St. Paul, is secretary of the board.

A Section of Wooden Field Stand Collapsed just before a championship prize fight at Colorado Springs on Sept. 4. A length of 150 ft. fell to the ground, dropping some 500 people,

COLLAPSED SECTION OF TEMPORARY SEAT-STAND FOR PRIZE FIGHT AT COLORADO SPRINGS

of whom almost half had to be sent to hospitals. The portion of the stand which fell was in the upper half, 12 to 15 ft. above ground. There is dispute as to whether the stand was properly braced. A coroner's inquest is in progress.

A Dike to Divert the Flood Waters of the Los Angeles River, heavily laden with silt, from entering Los Angeles Harbor will probably be undertaken within a short time. The River and Harbor Bill recently enacted provided an appropriation of $1,080,000 for this work, of which $500,000 was made immediately available. The appropriation was conditioned, however, on Los Angeles guaranteeing to assume the responsibility for right-of-way and the construction of roads and bridges, and also agreeing to maintain the work after completion. The voters will probably pass on this proposition, which involves an expense to Los Angeles of nearly $1,000,000, at the November election.

The Electrolytic Sewage Testing Plant at Decatur, Ill., is being continued in operation beyond the test period, both for demonstration purposes and to ameliorate, to the extent of its capacity, the pollution of the Sangamon River. The Electro Chemical Co., 824 Monadnock Block, Chicago, will continue to pay the wages of plant attendants. The city has engaged H. R. Lee as chemist in charge. The city is under contract to install an electrolytic plant to treat all its sewage, in case this 1,000,000-gal. test plant is found to have met the contract requirements. The city is also under orders from the Illinois Rivers and Lake Commission to cease polluting the Sangamon River by Jan., 1916. W. S. Shields, Hartford Building, Chicago, described the Decatur test plant in "Engineering News," of Aug. 24, 1916, p. 371.

A Suspended Monorail Railway, similar in general design to the Barmen & Elberfeld Ry. in Germany, was recently projected in California between Hopland and Lakeport, a distance of 24 mi. A standard-gage steam railway was projected over the same route two years ago, but after spending some $86,000 on the enterprise the company was financially unable to carry it further. The Monorail Co. applied to the California Railroad Commission for permission to issue stock and bonds to raise money for constructing this road. The Commission, in an opinion filed June 10, 1916, shows that the estimates of the cost of construction of the monorail road were about $50,000 per mi., or about double the cost of a standard steam road, and that the estimates of expenses and earnings on which the company based its hopes of selling its stock and bonds were contrary to general experience in railroad operation. The Commission therefore refused to approve the project.

Kansas City to Try Reinforced-Concrete Water Main—The Board of Fire and Water Commissioners of Kansas City, Mo., and Burton Lowther, water-works engineer have returned from a trip to Oregon and Washington where they went to investigate the success of reinforced-concrete conduit under pressure. Kansas City's water-supply is taken from the Missouri River above Kansas City, Kan., and by means of a 48-in. riveted steel pipe and a 36-in. cast-iron main is carried under a maximum head of 50 ft., for a distance of about 18,000 ft. to a 7-ft. tunnel under the Kaw River, and thence to the main Turkey Creek pumping station on the Missouri side. The 48-in. steel main has developed several bad leaks recently, although it is only 12 yr. old, and at other places where it has been uncovered it has been badly corroded. It is proposed to build a new 48-in. line immediately to provide for the increased water consumption and to replace the 48-in. steel main with a fourth line as soon as necessary. By using reinforced concrete a very material saving can be effected, estimated at from $20,000 to $40,000 per mi. The United States Reclamation Service projects examined by the city representatives showed that concrete had been successfully used for flow lines. One 46-in. pipe on the Umatilla project in Oregon has carried 110 ft. head for 10 yr., and showed but two surface leaks of minor character when inspected. The Board has asked Mr. Lowther to prepare plans and estimates for one 48-in. reinforced-concrete flow line.

PERSONALS

George E. Clifford has been appointed Chief Engineer of the Philadelphia Bureau of Charities.

W. R. Woolrich, of the University of Wisconsin, has been appointed Assistant Professor of Mechanical Engineering at the University of Tennessee.

Oliver W. Connet, M. Am. Soc. C. E., recently with the city engineering department of Baltimore, Md., has been appointed Valuation Engineer of the Western Maryland Ry.

P. C. Powers has been appointed Street Commissioner of Memphis, Tenn., to succeed Thomas Estes. Mr. Powers was Street Commissioner under a former administration.

Charles Palmer, of Latrobe, Penn., has been appointed Engineer of the Shenango Land Co., of Sharon, Penn. He was formerly Engineer of the Latrobe and Connellsville Coal and Coke Co.

A. L. Kenyon, M. Am. Inst. E. E., has resigned as Manager of the Alabama Power Co., Anniston, Ala., to accept the same position with the Columbia Railway, Gas and Electric Co., Columbia, S. C.

Homer C. Johnstone, formerly with the Midvale Steel Co., as Manager of its Chicago and New York offices, has been made Manager of the Steel Department of Gaston, Williams & Wigmore, Inc., New York City.

J. M. Rabb, a civil engineer formerly with J. E. Sirrine, Mill Architect and Engineer, Greenville, S. C., has accepted a position with the Southern Engineering Co., Charlotte, N. C., and will have charge of a branch office at Greenville.

Charles P. Jaeger has resigned as Commissioner of Water of Cleveland, Ohio, because, it is stated, he is no longer willing to assume the responsibility of the Water Department with no voice in selecting or dismissing his assistants.

Elmer E. Yoke, of Annville, Penn., has been appointed Works Engineer of the Gilbert & Barker Manufacturing Co., Springfield, Mass. He is a graduate of Lehigh University and has been with various steel companies in Pennsylvania.

C. J. Renner, Assoc. M. Am. Soc. C. E., has resigned as Superintendent of the Louisiana Water Co., Louisiana, Mo., to accept a position in New York City. He is succeeded by A. F. Porzelius, of the Birmingham Water-Works Co., Birmingham, Ala.

Charles Scott Lauders, Assoc. M. Am. Soc. C. E., Consulting Engineer, New York City, **Reuben Davis** and **Alan M. Ferebee** announce the formation of the Substructure Co., Inc., 115 Broadway, New York City, specializing in foundation and underpinning work.

John R. Lapham, Jun. Am. Soc. C. E., former Instructor in Civil Engineering at Pennsylvania State College, has been appointed Assistant Professor of Civil Engineering at George Washington University, Washington, D. C., succeeding Prof. Nathan W. Dougherty, resigned.

George C. Andrews, Assoc. M. Am. Soc. C. E., former Resident Engineer of the New York State Barge Canal at Lockport, N. Y., has been appointed Supervising Engineer of the water-works of Buffalo, N. Y., under the new commission-plan government. He will give particular attention to systematizing records and similar work.

Prof. E. A. Fessenden, M. Am. Soc. M. E., has been elected head of the Department of Mechanical Engineering of the Pennsylvania State College. He was graduated from the University of Missouri in 1904. After several years with the Etna Foundry and Machine Co., of Springfield, Ill., the Babcock & Wilcox Co., Bayonne, N. J., and the turbine and condenser departments of the Westinghouse Machine Co., Pittsburgh, Penn., he was appointed Associate Professor of Mechanical Engineering at the University of Missouri.

OBITUARY

Frank McMillan Stanton, M. Am. Inst. M. E., died at his home in New York City, Sept. 11, aged 51 years. He was a son of John Stanton once widely known in the copper-mining industry. He was graduated from the Columbia University School of Mines in 1887. For over 20 years he was Superintendent of the Atlantic Mining Co., of which his father was President. Later he was identified with the management of other Lake Superior copper-mine properties.

John V. Beekman, M. Am. Soc. M. E., for many years connected with the Lidgerwood Manufacturing Co., New York City, died at his home at Plainfield, N. J., Sept. 11. He was born in 1842 at Somerville, N. J. About 1870 he engaged in the manufacture of rotary engines, pumps, etc., being a member of the firm of John A. Lighthall-Beekman & Co., with works at Imlay St., Brooklyn, N. Y. This company was absorbed by the Lidgerwood Manufacturing Co. in 1873, Mr. Beekman assuming charge of the works of that company. He was the inventor of many improvements in hoisting engines.

ENGINEERING SOCIETIES

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

AMERICAN CHEMICAL SOCIETY.
Sept. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickly, Penn.

The Efficiency Society is planning an open conference to be held in New York, Nov. 16 to 18. W. B. Richards is chairman of the committee, 52 Broadway, New York City.

The National Smoke Prevention Association will hold its 11th annual convention Sept. 26 to 29 in St. Louis at the Planters Hotel. The secretary is J. A. Troy, 510 Locust St., St. Louis.

The Engineers Society of Western Pennsylvania, at its first meeting of the season on Sept. 19, will be addressed by J. Lowenstein, Engineer of the American Bridge Co., on the Hell Gate Bridge.

The American Railway Bridge and Building Association has made arrangements for its 26th annual convention, Oct. 17 to 19, in New Orleans, at the Grunewald Hotel. The secretary is C. A. Lichty, C. & N. W., Chicago.

The American Society of Safety Engineers had an outing on Sept. 9, on Point View Island, College Point, N. Y., where the second annual frolic and shore dinner was held. The regular monthly meeting will be held on Sept. 27 in the Engineering Societies Building, New York City.

The Traveling Engineers' Association will hold its annual convention Oct. 24 to 28 at the Hotel Sherman, Chicago. The arrangements will be the same as planned for the Sept. 5 convention, which had to be postponed owing to the railway-labor difficulties. The secretary is W. O. Thompson, General Offices N. Y. C. R.R., Cleveland, Ohio.

The Portland Cement Association held its fall meeting Sept. 11 to 14 in Detroit. Nine sessions were held. An inspection trip was made over the Wayne County road system, and at one of the sessions Edward N. Hines, Chairman of the Board of (Wayne) County Road Commissioners, presented a paper entitled "The Concrete Road."

The Association of Edison Illuminating Companies at its annual convention on Sept. 7 at Hot Springs, elected the following officers: President, Peter Junkersfeld; vice-president, L. L. Elden; treasurer, W. W. Freeman; secretary, Geo. C. Holberton, of San Francisco. The assistant secretary is E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

The National Safety Council's annual meeting and conference will be held in Detroit, Mich., Oct. 16 to 21, in the Detroit Armory, and will include an exhibit. The program is 40 pages in length and will include 140 speakers. The National Safety Council was started a little less than three years ago, for the purpose of establishing a clearing house for information on accident prevention, sanitation, health conservation, etc. From 40 members the list has grown to 2,200. Five bulletins are distributed each week. The secretary is W. H. Cameron, Continental & Commercial Bank Building, Chicago.

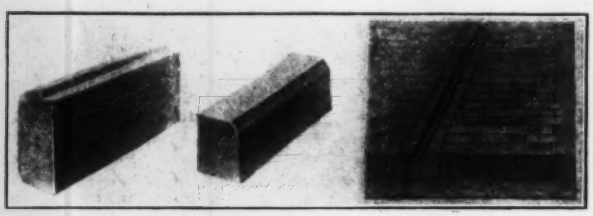
The Fourth Annual Efficiency and Welfare Conference under the auspices of the Pennsylvania State Department of Labor and Industry and the Engineers' Society of Pennsylvania, will be held at the Capitol, Harrisburg, Nov. 21 to 23. Representatives of most of the state's large industries and many engineering authorities will be present to discuss various legislation affecting industrial establishments, accident prevention, first-aid methods, occupational diseases, problems of employment, avoidance and settlement of labor disputes, Americanization of alien workers, fire prevention and factory problems. The complete program will soon be announced by Commissioner John Price Jackson.

The Atlantic Deeper Waterways Association opened a five-day convention in Philadelphia on Sept. 12. Plans were advanced for a continuous inland waterway from New England to Florida, of value both to commerce and national defense. On Sept. 13 the delegates went by water to Trenton, escorted thither by the United States torpedo boat "Barney" and a flotilla of river vessels. About 800 made this trip, which included an inspection of the entrance to the Delaware and Raritan Canal, one of the links in the proposed intra-coastal system. Major J. C. Oakes, in charge of government work on the Delaware River, predicted the dredging of a 25-ft. channel between Philadelphia and Trenton. He said that the Delaware River was comparable to the greatest European waterways, and that the Atlantic coast was the heart of the nation; along its shores were situated great steel and industrial plants and to defend this section, inland waterways were a necessity.

Appliances and Materials

Filler and Stretcher Paving Blocks

The accompanying sketch illustrates two special blocks for use in connection with T-rails in street-railway track paving. The filler block is equal in depth to the rail web and is wide enough to take a part of the wheel-flange way. The stretcher block is merely rectangular with one beveled edge. The



SPECIAL BLOCKS FOR TRACK PAVING

blocks are laid with their greatest length parallel to the rails, and with broken joints. The length of these special blocks is three times the width of an ordinary paving brick. They are made by the Nelsonville Brick Co., Nelsonville, Ohio.

* * *

A New Solenoid-Control Relay

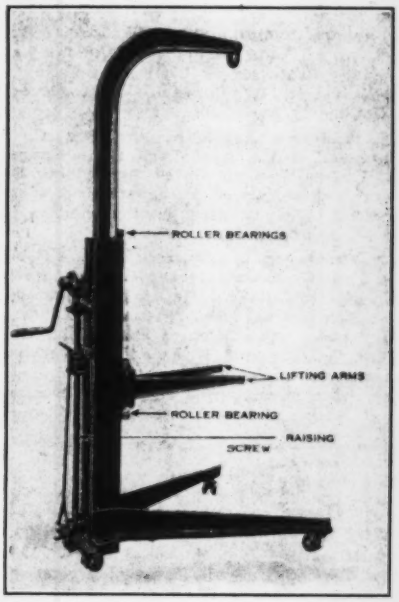
Solenoids for operating large carbon-break or oil circuit-breakers frequently require comparatively large currents in the closing solenoids. In such cases the contacts of the solenoid-control switch that controls the operation of the solenoid are not suited to operate the closing solenoid,

LARGE SOLENOID-CONTROL RELAY

and it is necessary to use also a control relay with its operating coil excited by the closing contacts of the control switch and the relay contacts in series with the closing solenoid. A relay for this purpose was recently developed by the General Electric Co. The relay consists essentially of a solenoid, plunger and contacts. There is a metallic connection, consisting of a small flexible lead, between the movable contact arm and its support. The contacts are kept clean by a wiping motion each time the relay is operated.

Light Portable Crane

The portable crane for shop and yard work, shown in the accompanying view, has a telescopic mast with head of the davit type, giving a height of 6 ft. 4 in. to 9 ft. 3 in. In addition, there is a pair of hinged arms for use in lifting or jacking, and these can be swung aside when the boom is being used. The operation of mast and arms is effected by means of a vertical lead screw with crank-handle drive and



PORTABLE CRANE FOR SHOP AND YARD WORK

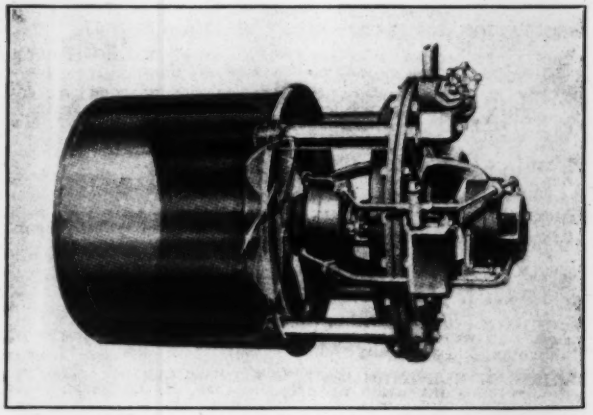
gears for high and low speeds. The base consists of two supporting beams with castors under their ends and under the mast. The machine has a hoisting capacity of 4,000 lb. and weighs about 350 lb. This crane is built by the Zin-Ho Manufacturing Co., of Chicago.

* * *

A New Turbine Blower with Novel Lubrication

A turbine blower recently placed on the market by the L. J. Wing Manufacturing Co., New York City, includes in its design a new method of lubricating, oil being used on the ball bearings instead of grease. "Power" states that the two ball bearings mounted on either side of the turbine are inclosed in large housings with ample reservoir space on either side of the bearings, so that each bearing rotates through a bath of thin oil supplied from a tank in front of the turbine face.

The method of mounting the bearings is another interesting feature. Instead of the bearing races being held in the



TURBINE BLOWER, SHOWING OILING SYSTEM

main castings in the machine, they are held in caps that are secured to the castings. When the cap is taken off, by removing four screws, the bearing is exposed and can be easily removed.